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Metallurgical & Chemical Engineering

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Being the Incorporation of
Electrochemical and Metallurgical Industry
and Iron and Steel Magazine

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A Charming Human Document

At the last New York City meeting of the American Institute of Mining Engineers in one of the iron and steel sessions the feature overshadowing completely in human interest the balance of the proceedings was a contribution to the discussion of one of the papers. It was made by Mr. Alexander E. Outerbridge of William Sellers & Co. of Philadelphia on experiments carried out by him many years ago on the growth of certain iron castings. Mr. Outerbridge spoke at length and really upset the schedule of the whole meeting, but he fascinated his audience and received an ovation. What was an old story to him was all news to his hearers. We fancy that Mr. Outerbridge's paper on "Metallurgical Processes in the Foundry," published elsewhere in this issue, must have had a similar enthusiastic reception when presented before the Philadelphia Foundrymen's Association. There is an incomparable delight in hearing a nestor of an industry speaking modestly of his work of a lifetime. And Mr. Outerbridge's paper is a charming human document. The American foundry industry may be well proud of its achievements and of the American metallurgists like Outerbridge who produced them. And then it is always pleasant to be reminded again and again how many real good things have come to us from quiet, unassuming, industrious Philadelphia. Two-score years of metallurgical life in Philadelphia are recorded in the paper.

Steel for War

When we entered the war there were predictions that the Government would require 5 or possibly 10 per cent of the steel output. The president of one of the steel companies, who seemed to employ an unnecessarily large factor of safety, asserted that the requirements would not amount to 20 per cent. Now there are estimates running as high as 40 or 50 per cent.

A bewildering mass of requirements in steel has accumulated already and perhaps the end is not yet. In the case of most of the groups of requirements there is not even a tentative estimate of the tonnage of steel involved, particularly in terms of the rate of output. For instance, to build ships of 3,000,000 gross tonnage there has been a rough estimate that 1,000,000 tons of plates and 300,000 tons of structural shapes will be required, but the 18 months' time in which the ships are to be built is purely a guess, and therefore the proportion of the steel output involved in 1,300,000 tons is not known. It would be between 2½ and 3 per cent if the deliveries were spread equally over a period of 18 months.

The steel required in building sixteen cantonments,

cities for 40,000 inhabitants each, might be thought to run into large tonnages, but it seems the total will be only a few tens of thousands of tons, and when the work is completed, in a very few months, there will perhaps be no more required in that quarter. In other construction work, such as of hangars, shipyards, etc., the tonnage of steel will be much larger. A report that circulated some time ago, referring to 200,000 tons of steel for hangars, received little credence, but in the light of later information the estimate does not seem unreasonable.

In the case of much of the war activity there is a replacement in form rather than in substance. Thus the Government will probably order a large number of freight cars and locomotives, which in normal times would be bought by the railroads direct. The railroads have not been heavy buyers, partly on account of prices asked and partly because the car and locomotive shops could not secure full supplies of steel. The Government can take a hand and control both prices and deliveries. The car shops, which for months have been working at only about half capacity may eventually be working at nearly full capacity.

As to the shell requirements of the Government, the only important steel buying thus far has been 81,000 tons for 9,000,000 3-in. shrapnel and high-explosive shells. Much larger tonnages will, of course, follow.

In 1916 the steel exported directly to the Entente Allies or consumed in manufacturing wares for them amounted to between 15 and 20 per cent of our total steel output. The remaining exports, perhaps 5 per cent, went to neutrals. Exports to neutrals are, of course, practically shut off. If our Government buys more largely for the Allies than they did last year their proportion may be 20 or 25 per cent, and if ours were the same the total would be 40 or 50 per cent. The remainder, for ordinary consumption in the United States, would be 50 or 60 per cent, against 75 or 80 per cent last year, no great change after all, particularly considering that the percentages now refer to a somewhat larger steel making capacity. In view of the facts that commercial building on a large scale is likely to dwindle to insignificant proportions, and that much shop capacity to work steel into finished forms will be diverted from private to Government work there is no safe ground for assuming that steel will continue to be as scarce as it is now.

The Art-Science Divorce Scandal

In the cheerful days when Rembrandt van Rijn arranged, had, and from a reasonable distance enjoyed his own funeral and then watched the prices of his pictures soar; when Frans Hals would sober up now and then and dash off an immortal canvas with thirst driving him to short-cuts that to this day painters strive after at hard labor; when Jan Steen would not listen to the voice of propriety but chortled with unholy glee whenever a drunken row began—and painted it, artists "went in" for science. They kept linseed oil for fifty years and more and were very careful to select and grind and mix their own colors. They clung to renaissance traditions, but the traditions were sound—as witness their canvasses to this day. Later painters experimented without the vision of the research mind, and their canvasses show their frequent errors. It is not always wise for the uninformed to try experiments. Then followed the trade of color making as a thing apart from painting, and the painters lost interest in it. Chemistry has come into the paintmakers' trade, but artists, as a rule, do not know or care about it. They buy by label and discuss the qualities of Permanent Green, for instance, without knowing what it is made of.

Science is not welcomed into art any more. Somebody always fears that it is too material and that the artist's gift of the vision of beauty will fade away if he but knows the substance of the materials he uses. Of course, if his artistic sense is so frail that it will wither in the face of needful knowledge, it goes without saying that it is not robust enough to make a real artist of him. In a very distinguished company, not long ago, the deterioration of the work of a well known artist was considered during an informal discussion on landscape painting. A modest member of the company ventured the suggestion that the particular painter's geology was defective; that his later imaginative work was based on a series of geologic sequences that went backward. He was immediately taken to task for demanding that any painter should engage in a study so disturbing to his work and so contrary to the spirit of his task. The others were unanimous in denying any worth in his contention. Why on earth should a painter of landscapes know anything about geology? The surroundings were beautiful and the company distinguished and learned in the humanities, but the conversation was not enlightening. The instance of a figure painter was mentioned who studied anatomy diligently and yet who did not paint well, and it was claimed that the knowledge of geology cannot aid in the enjoyment of a landscape. Such were the pearls of thought contributed.

No, science has not yet been welcomed back into art. And because of this divorce proceeding men of science are occasionally found who are rather deficient on the artistic side. The cry is persistent that many good engineers lack the art of expression, and the complaint is well founded. The demand is not that they shall be able to say nothing at all with elegance and style, but rather that when they have something to say, they be able to say it. The other day there was a meeting of classicists at Princeton at which the two old idols of culture, the Greek and Latin languages, were glorified all day long as the only leaders into the graces of life. Now we know that this is not true and that compulsory classics do not make a man competent to say what he means. It is his habit of thought that gives him this, induced by training and experience in saying and reading things that are difficult to express, told with the exact, precise shade of meaning desired. This it is that gives him his intellectual background. The trouble with men who have scientific thoughts and pipe-fitters' methods of speech is not that they have failed in having been

"put through" Latin or Greek. Their trouble is more likely to be that they have graduated from local newspapers and monthly and weekly periodicals that will print any kind of idiotic pap to increase their circulation, over into physics and chemistry and mathematics. They have not engaged in refinement of thought in any language before beginning with science. And science is new, it is without traditions of expression, so that it is much more difficult to tell of reactions and processes than it is to write a sonnet. Anybody can write a sonnet; all he needs is a rhyming dictionary and the resolution to use fourteen lines to tell, for instance, that he does not like the weather when it is cold—or hot. We repeat, with time and patience anybody can do it; thousands and thousands have succeeded. But when it comes to setting forth in fourteen or twenty-eight lines either in prose or measure, so that the idea is not only correctly stated by the writer but may also be understood by the lay reader, the phase rule of Willard Gibbs, we confess that we have never heard of the genius who could do it.

Now some men are easy talkers with very little to say, while others who are among the greatest of men, would rather tackle an I. W. W. strike than make a speech. But we are not discussing oratory or talking for show. We are considering the need of clear, succinct definitions of conditions and processes that are needed in every control and every research laboratory, in every technical report and in giving commands as well as acknowledging them. There's a lot of psychology inside of most men's heads, just a little further in than their ears, and the reactions take place according to the language used.

The use of language, of our own language, is an art, a subtle but very important art that is in daily use; and it is far more needed in business than it is in idleness. Mastery of it is attained by the cultivation of a taste for it. The boy who does not try for this thing before he undertakes the more detailed preparation for his career is an ass. He will not gain it by reading stuff written to sell to those who lack it, and unless he has the industry to acquire it in the days of his youth he will sidestep along through life, always ashamed and always embarrassed by the need of it.

Decadence of the Iron Casting

It is not chance, but the orderly development of industry that has caused the iron casting to occupy a smaller and smaller place in what is broadly known as "the iron industry." The chief factor in the development has not been strength or safety, as might have been supposed. In 1899, before a meeting of one of the foundrymen's associations, a mechanical engineer of some note, lately returned from abroad, observed that he was not particularly interested in their discussions of iron foundry practice, because he had become convinced that the future of the industry lay in the steel casting. Events have proved that he was wrong. While the production of pig iron has increased three-fold since 1899, the tonnage of steel castings produced bears a relation of only 3½ per cent to the tonnage of pig iron. If safety and unit strength were the important factors the steel casting industry would have expanded much more rapidly. If it is a case of the total strength of the member the iron casting has much to commend it, for on account of size in proportion to value per pound one obtains a large radius of gyration at a low cost per pound, the iron casting being cheap for its strength even if only the outer portions are stressed.

There are no statistics of the production of iron castings, but the production of pig iron in grades used by the gray iron and malleable iron foundries furnishes an index. The statistics of pig iron production, segregated by grades, were first gathered for the year 1900. Then we have it that in 1916 17 per cent of the pig iron went to iron foundries, against 23 1/3 per cent ten years earlier and 31 per cent 16 years earlier. The figures are conclusive even though not entirely accurate as a measure of the production of iron castings. The proportions of scrap melted may have changed, but the probability is that the proportion of scrap to pig iron decreased, as the open-hearth furnace has in recent years bid favorable prices for scrap.

It is a change in manufacturing methods that has been chiefly instrumental in relegating the iron casting more and more to the background, in a sense, the greater and greater standardization. While the molding machine represented a great step it cannot compete with the press and other instrumentalities for working rolled steel into finished wares. We make things more and more to one pattern. From locks, bolts and hinges up to the heaviest articles we find rolled steel supplanting the iron casting, and indeed when we look about us to see what the largest castings are used for we find a great many of them in machinery for making or fabricating steel! In those cases the iron casting is merely digging its grave.

It has been impossible for the cost of converting pig iron into the finished casting to be decreased as greatly as the cost of converting pig iron into finished steel products because the margin was not sufficiently large at the outset. The manufacture of steel pipe, for instance, has been very greatly improved whereby when prices are low steel pipe sells for only about twice as much as cast iron pipe. Accordingly, the production of welded iron and steel pipe and tubes in 1916 was two and one-half times as large as the production of casting iron pipe and fittings, although that is one of the large items in the iron casting group.

The specialization that has fostered the use of rolled steel has not been confined, of course, to the industries that work up the steel, but has permeated its manufacture as well, whereby the old-fashioned general purpose mill has largely disappeared, to be replaced by mills that are highly specialized, continuous, tandem and otherwise. When the demand for a given form of rolled steel has doubled it has been possible to devise means for making it more economically, while that has not been the case in similar measure with the iron casting industry.

Readers' Views and Comments

Chemists in the Making

To the Editor of Metallurgical & Chemical Engineering

SIR:—An anonymous writer, whose name is not hard to guess, has been telling his fellow members of the Chicago section of the American Chemical Society, his early experiences in the practice of chemistry; setting forth his reminiscences in several issues of their monthly bulletin. He admits that he is now prosperous, but prosperity was slow in coming to him. We shall describe one of his adventures because it throws light upon some modern promotions of chemical enterprises that have come under our observation, undertaken in a similar manner.

This particular chemist had been analyzing ores in the Pittsburgh region but bad times came along and the furnaces closed down. In answer to an advertisement he accepted an offer to become the "chief chemist" of the R—— Chemical Company of Chicago, at a modest salary. Mr. R——, the founder had been reading chemical books and had discovered nothing less than wonders. It was too easy! Here were chemists, pining and sighing away for a method to fix nitrogen from the air, and there were the directions, plain as your hand before your face, all printed out in the chemistry books. It merely confirmed him in the opinion that of all blind mortals those scientific theorists were the blindest.

His epoch-making discovery consisted in this: he gathered from his reading that nitric acid was a regular old crackerjack of a solvent; that it would eat into almost anything. He made careful notes of some of the things it would dissolve and of some that it wouldn't. He also read that when an electric spark is passed through air, a certain amount of nitrogen is oxidized to nitric oxide and that with this, nothing but more air and water is needed to have it turn into nitric acid, all of itself. Then he bethought himself of the poor gold miners who dug up vast quantities of earth and rock to produce very little gold. He looked up his notes and found that nitric acid would dissolve nearly everything, as far as he could figure it, that was in the ore except the quartz and the gold. Then he proceeded to design and patent a nitric acid machine that produced a lot of sparks and had a container attached to catch the nitric acid as fast as it was made. The rest was easy. All the miners had to do was to whirl in and buy one or more of his nitric acid machines, set them up and, by making all the nitric acid they wanted, concentrate their ores right down to gold nuggets and quartz, on the spot. Nothing like it had been thought of in the way of concentrating ores before or since—in the history of man, let us add, to give the promotion twist to our language. He disclosed his secret to a friend who had done well as salesman for a wholesale grocery house and the friend threw up his job, mortgaged his house for $10,000, and came in as a partner on the ground floor. Then the company was organized, offices were taken, a campaign of advertising begun, a shop was opened up, mechanics were set to work and a draughtsman with an engineering past but too fond of drink to be steady was engaged. Orders came in and the prospects were hopeful, although the bank account was getting low and it seemed advisable to have a chemist at hand for talking purposes as the first of the apparatus drew near completion.

At this point the chemist from Pittsburgh entered and he found that not a single feature of the whole layout had been tested. He induced the draughtsman to sober up because he had a rare sense of mechanics, and the best thing the new chemist and the sobered-up draughtsman could do was to work out a plan of research that, hurry as they might, would take at least two years to reach results. They reasoned that the various effects of temperatures, pressures and other factors would have to be determined and plotted before an apparatus could be designed, and concluded that even if they made a lucky strike they would need to know under what physical and chemical conditions they obtained it. They were working in utter darkness and they urged that, before the money was all spent, they make at least a few tests.

To Mr. R—— this was twaddle, piffle, rank theory and useless and undesirable experimenting. He pointed out on page 701 of Richter's Inorganic Chemistry how part No. 1 of the apparatus was bound to succeed and on page 357 of Muspratt he demonstrated how part No. 2 could not fail. He was so certain of results that he did not even care to be present at the first trial. If his chemist and draughtsman would only do as he told them and go ahead and construct the apparatus, there would be less trouble—and less talk. The partner with the mortgage on his house stuck to his job at the office and continued to make sales for later delivery. In time the apparatus was built as designed and all the parts were connected and set in motion. After operating at capacity for two hours, delicate reagents indicated slight traces of nitric acid. It was hardly to be smelled but the slight traces—albeit no more—were proven to be there. That was the capacity of the apparatus. The chemistry books were right but the trouble was that Mr. R—— did not speak the language. He was sent for and when he arrived, according to the author, he "swore like a Turk at Muspratt and Richter—and then took everybody out for a drink."

That was the end of the R—— Chemical Company and the chemist labored long at many a task within and without his profession before he struck his gait. The type of practical men who will not submit their theories to the test is far from extinct. Many of them are still abroad in the land. It would be a dreadful insult to call them theorists; they would deny it with warmth and vigor. The term theorist is an expression of opprobrium that seldom has a definite meaning and is a word often applied by the ignorant to those who believe in looking things up before they go ahead. It would make this issue unmailable to print the practical man's usual synonym for "theorist."

E. H.

Buffalo Meeting of theAmerican Institute of Chemical Engineers

The ninth semi-annual meeting of the American Institute of Chemical Engineers was held in Buffalo from Wednesday, June 20, to Friday, June 22, inclusive, with headquarters at the Hotel Statler. It was an excellent meeting, and a most enjoyable and profitable one. The attendance was exceptionally good in spite of the urgent requirements on the members' time at present, and the members showed by their attendance, and by the discussions, that scientific meetings are extremely valuable in the present crisis, and that there are more reasons for holding them now than ever in order to co-operate with each other and with the Government to the fullest extent.

Wednesday Sessions

The meeting was called to order on Wednesday morning in the Hotel Statler by F. A. Lidbury, chairman of the local committee on arrangements, who introduced David C. Howard, first vice-president of the Buffalo Chamber of Commerce. Mr. Howard welcomed the Institute to Buffalo and outlined the wonderful industrial growth of the city which he had been in close touch with. He made a special plea for the Institute to exert its influence to obtain the right to divert more water for power purposes on the American side of Niagara Falls, on account of the great shortage of power there.

President G. W. Thompson responded on behalf of the Institute and then opened the business meeting.

The secretary, J. C. Olsen, read the report of the Council, which contained some interesting announcements. In the Council meetings co-operation with the Government had been discussed. Applications had been received for the affiliation of student societies, but it was not thought advisable to do this at present as many of the professors in charge of the societies are not in active chemical engineering work. The feasibility of establishing associate membership was also discussed, but no definite action was taken. The Council decided to recommend the appointment of a committee to consider the further adoption of the metric system. It also authorized the treasurer to invest $500 in Liberty Bonds. It was not considered necessary to take a census of all the members and their specialties, as it was thought that the Bureau of Mines census covered this.

In connection with the action of the Council on the metric system, the secretary, J. C. Olsen, announced that the Institute had sent out literature to its members of both the American Institute of Weights and Measures (opposing the metric system) and the American Metric Association. He also read a letter from Dr. Baekeland expressing surprise that the Institute had sent out circulars against the metric system, and urging the use of this system. Dr. Palmer moved that

PHOTOGRAPH TAKEN AT BUFFALO MEETING OF AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

a committee be appointed to carry out the Council's recommendations. Mr. Lidbury said that the metric system should be considered by the Institute from the standpoint of the chemical engineer and not from the standpoint of the public. Professor Withrow did not think it advisable to urge the adoption of the system unless the individual membership was circularized to find out whether any would be seriously affected. Mr. Lidbury replied that it was not the intention to urge the adoption in any particular industry, but simply to go on record as favoring the system. After the discussion the motion was passed to appoint a committee.

The secretary in his report stated that the membership consisted at present of 229 regular, forty junior and one honorary member.

The report of the Committee on Engineering Education was read by Professor Withrow. He did not think that the committee could do much during the war, as many of the professors have their time taken up by the Government and by the industries. Professor Withrow made a strong plea for the continuation of all chemical education on an even stronger scale than ever during the war. He said that the Society for the Promotion of Engineering Education would meet with the Council of National Defense in Washington instead of at Northwestern University as originally planned. Means will be discussed for changing the curricula to meet war demands. The committee recommended that the Institute ask all teachers to instruct chemical engineers in the fundamentals of topography, military engineering and explosives. In the discussion on this recommendation it was suggested that the chemical engineers were so small in number that it was not advisable to teach them military engineering.

After considerable discussion on the question of keeping chemists in the industries and in their proper places, the president appointed a committee to report Friday morning, after having drawn up resolutions on this question to send to the proper authorities.

The president announced that invitations had been received from Chicago, St. Louis and Columbus, Ohio, for holding the winter convention.

MANUFACTURE OF GLUE

The first paper was presented by **A. Lowenstein** of Chicago, Ill., on "Some Machinery Employed in the Manufacture of Glue." The author stated that most of the distinctive improvements in glue manufacture had taken place in the chilling, cutting and spreading of the glue, and he confined himself to a discussion of these subjects. Glue manufacturers have been very conservative in adopting new equipment.

The old method of handling glue consists in running the concentrated solution from the evaporator into wood or galvanized-iron pans and chilling them by running water or in a refrigerating room. The cakes formed are then cut with wires or knives into blocks or sheets. They are then spread on nets.

The old methods of chilling and cutting glue require considerable space for cooling room, the pans often rust and leak, "tops" and "bottoms" are formed, and in warm weather difficulty is experienced with liquefying organisms. The author mentioned a chilling wheel used successfully at present by one of the large companies, and having brine circulated in the rim. This wheel is understood to spread a sheet 30 in. wide.

He also described the continuous method of chilling, cutting and spreading patented by Maurice Kind (1,046,307), and the machine used in this method. It consists in running the glue or gelatine from the evaporation into a head tank over a continuous belt, subjecting it to chilled air and cutting the semi-solid strips into sheets. This machine is used by a large number of glue manufacturers. It requires a space of 85 ft. by 10 ft., uses 10 hp. and 10 to 12 tons of refrigeration. The capacity is 4300 lb. of dry glue per twenty-four hours, based on spreading ¼-in. sheets and a feed containing 16 per cent solids.

In discussing the problem of drying the author stated that it is still generally done in straight tunnels with longitudinal circulation of warm air. Vacuum driers have not been very successful.

In the discussion it was asked whether any attempt had been made to use moist air in drying glue. Mr. Lowenstein replied, that to his knowledge, no deliberate attempt had been made to use moist air as it is desirable to form a skin on the surface of the glue. For this purpose dry air has always been used.

TREATMENT OF SEWAGE BY AERATION

In papers read at previous meetings the author, Prof. Edward Bartow, described experimental work with activated sludge carried out in the sewage experimental station of the Illinois State Water Survey and the University of Illinois (see *Met. & Chem. Eng.*, Vol. XIII, page 901 (1915). The removal of ammonia and the development of nitrate nitrogen were also described, and it was shown that the sludge was valuable as a fertilizer. The present paper describes further work carried out at the above mentioned sewage experimental station.

A continuous-flow plant to work on the activated sludge process and which was expected to handle 200,000 gal. of sewage and sludge per day was put in operation May 25, 1916. It was shut down June 11, 1916, to repair leaks in the concrete work. The plant was again operated from July 11 to Oct. 22, 1916, the amount of sewage added varying from 61,000 to 177,600 gal. per day. About 2 cu. ft. of air per gallon of sewage was required to obtain stable effluents.

The plant contains a screen chamber and pumping pit, a grit chamber, an aerating chamber, a settling chamber, a blower room and a laboratory equipped with sludge-drying apparatus. There is also a sludge-drying bed and a pond into which the effluent from the process may be discharged. The sewage is drawn from the main sewer of the city of Champaign.

The plant was again started Jan. 17, 1917, after cutting out the grit chamber and substituting a short box into which the sewage is pumped. It has operated continuously till the present time.

A number of experiments were carried out on different methods of air diffusion. The results of these comparative tests indicate the superiority of Filtros plates as air diffusers over perforated pipes such as used in the tests. The wooden blocks were hard to handle, partly on account of the design of the containers. They showed signs of deterioration even in the short time used. No difference could be distinguished between coarse and fine grades of Filtros plates.

It is necessary to have a practical and economical method of drying the sludge. Sand beds have not proven

successful. The sludge contains 98-99 per cent of moisture. In experiments so far filter presses have not given good results. A rotary filter containing Filtros plates was also tried, but did not give satisfactory results. A modified 8-in. basket-type centrifuge and a modified cream separator were tried. The holes of the centrifuge were covered with a strip of rubber packing. The best results with this machine were obtained at a speed of 1500 r.p.m., which was the limiting speed.

Sludge cake containing from 85 to 86 per cent of moisture was obtained by the cream separator in six to eight minutes, which showed the desirability of making further experiments. A specially designed centrifuge was obtained from the Tolhurst Machine Works of Troy, N. Y. The machine was 1 ft. in diameter, 9½ in. high, and at 1800 r.p.m. exerted a centrifugal force of 550 lb. Sludge cake containing 88 per cent moisture was made with this machine. A 40-in. machine would deliver, on the basis of the experiments with the smaller machine, about 9340 lb. of sludge containing 88 per cent moisture, or about 1100 lb. of dry material. On the supposition that ½ ton of dry material is obtained from 1,000,000 gal. of sewage, one 40-in. machine would dewater 1,000,000 gal. per day. The machine appears practical to prepare the sludge for a dryer.

In the discussion which followed Dr. Wm. P. Mason asked what the nature of the effluent was. The author replied that it usually had a turbidity of less than 5 parts per million and was practically water white. The activated sludge method has been used on stock yards waste, requiring 4 cu. ft. of air per gallon of sewage and an aeration period of eight hours. He said it takes ten days to get a new plant running well. Dr. Olsen asked what proportion of the nitrogen in the sewage was obtained in the sludge. Professor Bartow had no figures on this but thought that all the nitrogen in the sludge came from the solid material which was in the sewage.

INTENSIVE CHEMICAL PREPARATION

A paper was then read on "Intensive Chemical Preparation" by Dr. **Chas. S. Palmer** of the Mellon Institute, Pittsburgh, Pa. He spoke especially on the desirability of giving high and preparatory school students three years of preparation in chemistry, including inorganic and organic chemistry, qualitative and some quantitative analysis. He thought it would be of enormous benefit to the student in connection with his subsequent college training.

Dr. Olsen in discussing the paper said the argument was excellent for young men and women who never go to college. The average business man, banker, etc., could more intelligently support chemical and allied industries if he knew more chemistry. He thought chemistry should be made a compulsory subject in the New York City High Schools. But he said that in his experience better progress was made in chemistry in college by those students who had no chemistry in high school as the chemistry was usually improperly taught. He said the need was for not only more chemistry in the high schools but for better chemistry. The paper was discussed by several others with experience along these lines and it was the general opinion that the standard of teaching chemistry in high schools could stand considerable elevation, as in many instances the chemistry teachers were overburdened with other work.

WEDNESDAY EXCURSIONS

After luncheon at the hotel an automobile trip was taken by the members and ladies around the city through the residential sections and parks and then to the Buffalo Foundry & Machine Company's plant in the outskirts of the city. A tour had been arranged by the courtesy of the latter company which proved very interesting to the members. Booklets describing the plant and laboratories were distributed, which greatly facilitated the inspection. Each machine or piece of apparatus in the foundry and machine shop was numbered and corresponding numbers in the booklet explained each one. The company is building a large new research laboratory which will house all of the chemical, physical and semi-commercial testing laboratories. Large machining operations were first viewed, together with several large finished castings of dryers, nitrators, caustic pots, etc.

From the machine shop the party went to the plate shelf shop where welding and riveting operations were inspected. The foundry was next visited where the large castings were being poured and then a trip was made to the demonstration plant, where various small size dryers were in operation.

MANUFACTURE OF LINSEED OIL

This paper, which was read by **Glenn H. Pickard,** consulting engineer of Chicago, Ill., will be found in full on pages 12 to 16 of this issue.

In discussing this paper Dr. Wesson said the same problems were encountered in the manufacture of cottonseed oil. The chief improvements had been made in methods of cooking the seed. Dr. Thompson said the oil in the linseed cake was very different in amount in different spots and that it would be better to have the cake of even thickness.

TRADE WASTES DISPOSAL

The paper by **Harrison P. Eddy,** of Metcalf and Eddy, Boston, Mass., is published in full on pages 32 to 36 of this issue.

In the discussion Dr. Mason asked if anything had been done on the red liquor from sulphite pulp mills. Mr. Eddy had no data on this. Dr. S. P. Sadtler spoke of work being done on sterilization of tannery waste. Mr. J. V. N. Dorr spoke of a plant in Pennsylvania which had experimented with sedimentation by continuous settling. The results indicate that an overflow is obtained which complies with the law. Two 100-ft. circles are needed to take the complete output of the plant which is considered a large one. The solid material is incinerated. Professor Withrow mentioned a wood distillation plant which the authorities said was contaminating the water. They found that when the chlorine was stopped the creosote taste stopped which existed under chlorine treatment. Mr. Eddy said that no doubt under certain conditions a taste was encountered but it was less liable to be noticed when organic matter was present. This subject was also discussed by Messrs. Bartow, Mason, Snowden and Frerichs. It was brought out that hypochlorite did not produce any taste whereas chlorine did.

Thursday Sessions

The Institute was entertained all day Thursday at the Buffalo Canoe Club, near Crystal Beach, Ontario.

A steamer was taken at 10 a. m. to Crystal Beach and a launch from there to the Canoe Club. Several of the members walked along the beach to the clubhouse instead of taking the launch. The clubhouse is beautifully situated in Abino Bay, having a natural shelter from the heavy storms which are frequent on Lake Erie. The club has a private pier with two-story pavilion. The canoes are kept on the first floor, and the second floor, which is used for dancing, was given over for the holding of technical sessions. Upon arrival at the club a technical session was held in this pavilion.

SULPHURIC ACID

The session consisted of papers by Professor **James R. Withrow** of Ohio State University on the elevation and conservation of sulphuric acid and in discussion of these subjects.

Professor Withrow presented the results of some work which he had done on the elevation of sulphuric acid with waste steam, the object being to do away with air compressors. One of the methods mentioned consisted in simply substituting the steam for air in an acid egg. He said the absorption by the acid would be inappreciable in the short time during which the steam acted on the acid. Another method was to have three eggs, one for acid, one an intermediate air cushion and the third steam. In this manner no steam would come into contact with the acid. Another method was to use the waste steam to run acid pumps instead of electricity, or to have both available. Still another method was to have a sloping helical screw arrangement by which a steady stream of acid would be delivered. Steel pressure tanks can also be used in place of earthenware eggs.

Professor Withrow also spoke of the necessity of conserving our sulphuric acid to the greatest extent, as enormous quantities are needed for explosives and fertilizers and many manufacturers allow acid to go to waste because they have no concentrating system. He thought it wise to concentrate waste acid even if the operation only paid expenses, as it would furnish additional acid for fertilizers and explosives. Imports of pyrites and sulphur are not normal and the conservation of sulphuric acid is a vital necessity.

In discussing Professor Withrow's talk, Dr. Ludwig A. Thiele of Columbus, Ohio, said that elevation by steam was all right in concentration but that in the chamber process it was hard to find anything better than the acid egg. He had tried pumps of all kinds and found the greatest trouble to be with the packing. Braided lead is about the only material which will work.

Mr. Hugh K. Moore of the Berlin Mills, Berlin, N. H., asked whether anyone had ever tried making a cathode of the material used in the elevating machinery and passing a current to prevent corrosion. He had tried out a similar scheme successfully.

Mr. Arthur B. Conner of Detroit, Mich., said he thought the use of waste steam very practicable and did not see any reason why it could not be used.

In discussing ammonium sulphate for which sulphuric acid is used, Mr. Palmer said that in Germany, he understood, they were making ammonium carbonate from ammonia obtained by the Haber process, mixing this with gypsum and making ammonium sulphate. The calcium carbonate is used again to make ammonium carbonate.

Mr. Thiele said that several plants in Germany were using a mixture of calcium sulphate (gypsum), nitre cake, quartz sand and sodium sulphate for producing glass and oleum. He said 50,000 tons was being produced in this way and that it presents great possibilities. The mixture is heated in an electric furnace at 850-900 deg. C. Mr. Thiele thought that steam would have a bad effect due to heating in acid chambers. He mentioned a valveless centrifugal pump which gives good results.

Dr. Palmer said he had been recently informed that the Haber process was being used on a very large scale in subterranean passages in Germany. No one is allowed to go near the apparatus. Mr. Frerichs said he had understood that hydrogen and nitrogen were too expensive to use the Haber process and it had been kept going before the war by Reichstag appropriations. The cyanamid process was probably better. Germany uses the latter process on a large scale.

This brought up the question of power costs and Mr. Moore said that by using a steam turbine as a reducing valve with steam at 5 lbs. pressure power could be generated for $7.50 per hp. year. With steam at 250 lbs. pressure, the cost would be about $16 per hp. year.

Mr. Frerichs mentioned the Alabama River project, for which $9,000,000 had been appropriated by the Government to make the stream navigable. If $6,000,000 were added to it water can be diverted for power purposes. The Cyanamid Company offered to pay the interest on the money for being allowed to use the power. They figure $3 per hp. year as the cost. Mr. Thiele mentioned a great new power plant near Wheeling, W. Va., in the Fairmont region, where power can be generated very cheaply. It consists of a great by-product coke plant fed by gravity from the coal mines, the coal costing $1.20 per ton.

Thursday afternoon was spent in sailing, canoeing and walking. It was a most delightful day with what they call a "lady's breeze" and the afternoon was greatly enjoyed. Dinner was served in the clubhouse at 6.30 p. m. Following the dinner a technical session was held on the pier. This session had originally been planned for Friday evening but was transferred to Thursday evening and the banquet held Friday evening.

RENOVATING A SULPHIDE MILL

The author of this paper, **Dr. Hugh K. Moore** of the Berlin Mills, Berlin, N. H., presented a very interesting detailed description of work which he and his assistants had done at LaTuque, P. Q., Canada. The work was done in connection with renovating and reconstructing a pulp mill running on the so-called sulphate process. The paper was a splendid example of what chemical engineering can do and publication of this paper in full is reserved for a later issue.

In the discussion Doctor Palmer asked what the cost of coal was at that point. Mr. Moore replied that it was approximately $5 per ton. Mr. Harry O. Chute mentioned a multiple effect evaporator used in evaporating brine. Deposits collected on the tube which he thought consisted of magnesium sulphate.

He thought the acetylene method of removing this mentioned by Mr. Moore would have saved considerable money.

Owing to the lateness of the hour and to the necessity of taking the boat back to Buffalo it was decided to

postpone the reading of Mr. H. D. Baylor's paper on waste heat utilization until Friday morning.

The party returned to Buffalo on the 9 p. m. boat, arriving in Buffalo about 10.30.

Friday Sessions

The meeting was called to order Friday morning by President Thompson, who asked for a report of the committee appointed on Wednesday to draft resolutions urging the government to keep chemists and chemical engineers in their proper spheres. Professor Withrow read the resolutions which had been drafted. The substance of the resolutions was as mentioned that the American Institute of Chemical Engineers urges the exemption of chemists and chemical engineers unless their chemical ability is needed. The resolutions were unanimously adopted.

It was decided to send a telegram to President Wilson and other authorities if advisable, stating that the resolutions had been passed and explaining the reasons.

WASTE HEAT FROM CEMENT MILLS

A paper by **H. D. Baylor** of Sellersburg, Ind., was read by title as the author was unable to be present. The paper discussed the use of waste heat boilers with cement kilns at the Louisville Cement Co., Speeds, Ind. The gains realized were as follows:

(*a*) The decrease in fuel required to burn a barrel of cement from approximately 110 lb. per barrel to less than 100 lb., this being largely due to the preheating of the air for combustion by drawing it over the hot clinker and also in having the coal feed under absolute control.

(*b*) An increase of general efficiency of heat absorption from 37.6 per cent to 67.2 per cent of total heat supplied to kilns, the gain being shown in the boiler horsepower developed without an increase in fuel consumed in kilns per barrel.

(*c*) The recovery of at least one half the dust that was formerly carried out the kiln stack.

(*d*) And last but not least, the solution of draft control on the kilns through the use of the large induced-draft fan. This alone is quite worth while, since cement engineers seldom agree as to size and shape of kiln stacks; but with the variable fan speed obtainable each authority can have just the draft that best suits his conditions.

In discussing the paper President Thompson mentioned a smelter having fourteen reverberating furnaces, each one connected to a boiler, the boilers being connected to a common header. These boilers furnish power to run all the fans and one handling machinery. Dr. Moore said that the radiant heat furnishes a great deal of the heat furnished to waste heat boilers. Mr. Meade said that the problem was an old one but that recent success was due to the higher velocity of the gases.

POTASH RECOVERY FROM FELDSPAR

A paper on a new method of potash recovery from feldspar by Prof. **J. P. W. Frazer** and Dr. **E. Miller** of Johns Hopkins University, Baltimore, Md., was read by Dr. Miller. The paper described the results of experiments made last year in the production of potash and aluminum. Feldspar is treated with alkali forming a compound analagous to leucite, which can be leached. The feldspar is ground and mixed with 8/10 of 1 per cent by weight of potassium hydroxide. The hydroxide is used as a solution. The mixture is then evaporated to dryness and then heated to 200 to 300 deg. C. The leucite product is insoluble in water, hence the product is then leached, dissolving out the alkali. This solution is regenerated by treating with lime. The artificial leucite contains all the potash, the treatment simply taking out one molecule of silica. This artificial leucite is then treated with acid, any mineral acid sufficing. Methyl orange is used as an indicator. If hydrochloric acid is used an amount is taken equivalent to the potassium in the leucite. The end product from this leaching is analogous to kaolinite. This is treated with sulphuric acid and aluminum sulphate is obtained. The authors claim that the yield of potassium chloride is theoretical and that the yield of aluminum is about 86 per cent. A feldspar containing 10 per cent potash will yield ¼ ton of 80-per cent potassium chloride to one ton of aluminium sulphate.

THE AMERICAN POTASH INDUSTRY

A paper on the possibilities of developing an American potash industry was read by **Richard K. Meade** of Baltimore, Md. Publication of this paper in full is reserved for a later issue.

POTASH FROM BEET SUGAR FACTORIES

Mr. **H. E. Zitkowski** presented a paper on potash from waste liquors of beet sugar factories which will be found published in full on pages 17 to 19.

In the discussion on the potash symposium Mr. H. K. Moore said that evaporation was important in some processes. He thought that it did not pay to have more than four effects. By putting the liquor in the last effect and working backwards better results are attained. He is at present designing a 10-effect evaporator for concentrating digester liquor. He thinks that in the beet sugar industry backward evaporation would solve the problem as high final heat does no harm.

Mr. Thiele said that more time should be spent in exploring the country for potash deposits. The subject was also discussed by Messrs. Meade, Toch and Chute.

FRIDAY EXCURSIONS

On Friday afternoon the members and ladies were taken in automobiles to Niagara Falls. A stop was made on the outskirts of Buffalo at the Curtiss aeroplane sheds and a flight was witnessed. A special trolley car was provided in Buffalo to take the party around the gorge route. This car was furnished by the courtesy of the Buffalo Foundry & Machine Company. After the trip was over the party went to Goat Island and refreshments were served. The party returned to Buffalo about 7.30 p. m., the banquet starting about 8 p. m. The banquet was very well attended and excellent speeches were made. It was a fitting ending to a most successful meeting. President Thompson acted as toastmaster. F. A. Lidbury spoke of the chemists' obligations in the war and of several things that are being done. Prof. Alfred W. Smith of Case School of Applied Science, Cleveland, Ohio, spoke of the relation of education to the war. Prof. W. P. Mason gave an amusing talk on "temperance" and told several funny stories. Maximillian Toch gave a very interesting talk on the

various activities in which chemists are taking part during the war.

Great credit is due the local committee for the splendid entertainment features. F. A. Lidbury was chairman, David Bell had charge of the autos. David C. Howard was vice-chairman and Benj. H. Bonnar was responsible for the splendid Canoe Club outing Thursday. Other local committee members were W. M. Corse, C. M. De Forrest, Henry Russell, W. H. Watkins, and John Younger.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

Scientific Meetings in War Times

A number of our scientific societies have deemed it advisable "on account of the war" to either cancel or postpone their future meetings and conventions. The American Electrochemical Society disapproves of this action and at its recent board meeting adopted resolutions encouraging the holding of meetings.

Modern warfare is not so much a matter of prowess at arms as it is a stupendous engineering undertaking. To hasten this war to an early and victorious close our many thousand engineers must bring to bear every possible effort. However, individual, independent effort is not desirable at this time: *concertive* action is absolutely essential for the most efficient service.

In order to expedite the solution of many of the new problems that have arisen as a direct consequence of our martial state, unrestricted discussion of the problems (with but few exceptions) at scientific meetings is bound to give all of us a clearer understanding of the real points at issue, of the urgent needs of our country at this momentous hour.

Meetings of scientific and technical societies have ever served as a great stimulus for their members and have been a "clearing house" for many of the best thoughts and ideas of our professional men.

Let us follow the good example set us by England. Let us encourage rather than discourage the holding of scientific meetings in these war times. When England found herself confronted with a very serious shortage of sulphuric acid, glass, dyes, electrodes, brass, furnaces, etc., the scientific societies arranged symposiums on these subjects and invited not only all of the members to attend but further, urged those factory men who were not members to come to the meetings to give their views and experiences and to learn all they could in return.

Just as a large business corporation depends upon the organized effort and efficiency of the several units and departments, so does our government, now more than ever, look to the organized concertive effort of its large engineering bodies for quick and efficient results. Let us continue holding our meetings and hold them more frequently than ever before.

Colin G. Fink.

Granular Carbon Electric Furnace

By Samuel A. Tucker

A very useful furnace for maintaining temperatures considerably above those possible with the usual wire-wound furnace has been constructed in our laboratories.

There is a furnace on the market which operates with a granular carbon resistor, but the refractory parts are complicated and it is sold at such a high price that it is less useful than such a piece of apparatus should be.

The design here shown in Figs. 1 and 2 is simple to construct, the parts are inexpensive, it will reach a high temperature in a short time, energy consumption is not great, and the heated space is perhaps larger than is usually found in such furnaces. One difficulty in using a circular granular carbon resistor is in the tendency to uneven heating, particularly at the start. This furnace is therefore provided with four electrodes, as shown in the sketch.

The furnace body, 12 in. x 12 in. x 9 in., is of fireclay, with opening as shown. This particular shape was used because it happened to be in the laboratory; however, such a body could have been taken from one of the usual gas crucible furnace parts which are to be obtained on the market. Four holes are bored to admit the elec-

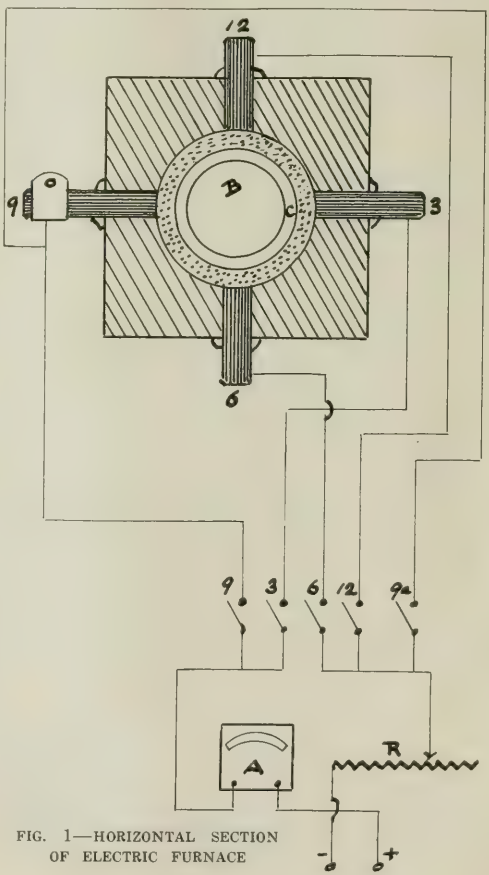

FIG. 1—HORIZONTAL SECTION OF ELECTRIC FURNACE

trodes about 1 in. diameter to the open space *B;* this space is partitioned by the carborundum ring *C,* which is 4 in. outside diameter, 3 5/16 in. inside and 3¼ in. high. This gives an annular space for the granular carbon connecting all four electrodes.

Granular carbon was obtained from the National Carbon Company, the size of grain being about 20 mesh, and was filled in to the top of the refractory ring.

The ring itself was constructed as follows (Fig. 3): Carborundum ground fine in a ball mill was mixed with

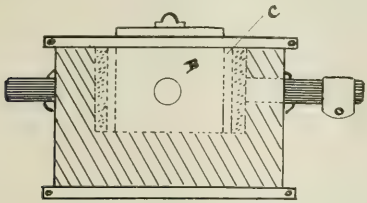

FIG. 2—VERTICAL SECTION OF ELECTRIC FURNACE

25 per cent fireclay and enough water added to make a thick mass. This mix was then tamped in to the cardboard mold shown in the drawing. The inner form at 1 and 2 is made by wrapping the cardboard on wood form 2 and holding it on the wood with small tacks or glue.

The outer form at 3 is also of cardboard held on the wood base projecting up inside the cardboard cylinder, as shown by the dotted line, and strengthened by the wood block at the top. In this way the form can be made quite strong enough and at the same time is sufficiently porous to permit of the drying out of the mixture. After thoroughly drying in a gas oven at 110 deg. C., it is transferred to a gas muffle and thoroughly baked at a temperature of 900 deg.-1000 deg. C. The mold is of course lost, but it is so easily made that it is of little consequence. The ring so constructed is quite strong enough for the purpose intended, and furnace cover, etc., may be made in the same way. Electrical connections are made as shown in the diagram from the five switches with wire of about 50-ampere carrying capacity. On closing switches 9, 3, 6 and 12 we have adjacent electrodes of opposite polarity and a short time will suffice to show whether the ring is heating evenly. Should this not be the case, and one quadrant appears to be too hot, this can be cut out by opening the switches for that position. When all have become evenly heated 9, 6 and 12 are opened and 3 and 9a closed, by which arrangement it acts as a two-pole furnace, which is the normal manner of running.

The following figures give a run with such a furnace using direct current at 120 volts through variable rheostats *R:*

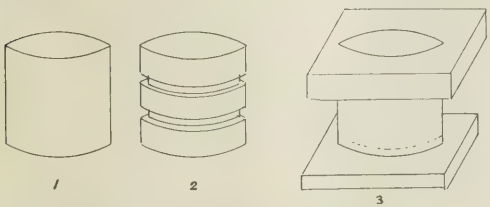

FIG. 3—CONSTRUCTION OF RING

Time	Amps.	Volts	Temp. Deg. C.	Remarks
9.30	25	..	..	1 pole
9.40	10	..	500 }	Changed poles
9.50	38	..	700 }	to regulate
10.00	12	..	720	2 pole
10.10	36	..	900	2 pole
10.20	18	98	1,000	2 pole
10.30	22	110	1,090	2 pole
10.40	23	98	1,200	2 pole
10.50	27	97	1,275	2 pole
11.00	24	98	1,300	2 pole
11.20	22	97	1,300	2 pole
12.00	22	97	1,300	2 pole

The furnace was covered with a carborundum disk and further with asbestos board with a small opening to allow the introduction of the thermocouple. In another case the furnace reached 1400 deg. C. in forty-five minutes using 50-60 amperes at from 51 to 53 volts.

It is necessary to have the electrodes fitted well to the openings provided in the body, and this can be done by wrapping with thin asbestos paper and luting with asbestos fireclay cement from the outside. Iron bands are necessary to clamp the body to prevent cracking.

The furnace described by A. W. Fahrenwald* is a very interesting design which has about the same purpose as this one. We have not had time to construct one of this type, but hope to do so in the near future, possibly changing the dimensions to permit of a larger working space and in this way can compare the advantages of each.

We believe that the refractory parts can be made for either type of furnace by the method here described, which would obviate the necessity of buying expensive alundum tubes, and it is possible that the carborundum parts would answer the purpose better than alundum.

Electrochemical Laboratory.
Columbia University.

American Society for Testing Materials

Annual Meeting at Atlantic City

The annual meeting of the American Society for Testing Materials opened on Tuesday, June 26, at the Hotel Traymore in Atlantic City. President A. A. Stevenson, vice-president of the Standard Steel Works, Philadelphia, Pa., presided.

On Tuesday morning the report of the executive committee was read. The membership is now 2167 as compared with 2071 last year. The translation of standard specifications into foreign languages has been delayed but the first ones are expected soon. Officers elected for the coming year are as follows: President Gen. W. H. Bixby, retired, Washington, D. C.; vice-president, Prof. Edward Orton, Ohio State University.

Tuesday evening was devoted to a reception and to the annual presidential address. Addresses were also made by all of the six past-presidents who, singularly, happened to be present. President Stevenson, in his address said: "The steel industry of the nation is drafting into its service all the newest inventions, labor-saving devices, intelligence and executive ability that can be employed in meeting the unprecedented call for steel products. Forty million tons were manufactured last year. That exceptional record will be exceeded this year, and extensions of plants are being hurried. The steel industry realizes the important part that it is to play in aiding the nation in winning the war. He outlined a plan for securing national standards through a committee made up of representatives of five national engineering societies.

*This journal May 15, 1917, page 565

The Manufacture of Linseed Oil*

By Glenn H. Pickard

Practically all of the flaxseed or linseed crushed in America is handled in the open-plate hydraulic press. Until recently a small proportion of the oil was won by the extraction of the seed with naphtha, but with the recent destruction by fire of the last plant operating on this principle, the process, so far as linseed oil is concerned, ceased to be in this country. The expeller is employed in a few mills, but the amount of oil produced by this means is a very small proportion of the whole.

CLEANING OF SEED

The first step in the manufacture of linseed oil from flaxseed is the cleaning of the raw material. The removal of the foreign matter in a consignment of seed is accomplished by specially designed flax screening machinery which employs the usual method of passing the grain over screens of proper sizes which separate, as completely as possible, the foreign matter from the flax seed. A current of air removes the chaff. This procedure will reduce the percentage of impurities to an amount lying between 1 and 2 per cent. The screenings are generally run through a separator, and the wheat, corn, oats and possibly other grains are sold as such, while the wild buckwheat, pigeon grass, wild mustard and other valuable weed seeds are sold to feed manufacturers.

The presence of oleagenous seed would deleteriously affect the quality of the linseed oil because the oils yielded by them are non-drying. The extent of the damage would naturally vary with the amount present. Non-oleagenous matter, particularly immature seeds and bits of the plants, impart a dark greenish color to the oil. The presence of much foreign matter will reduce the yield by absorption. It is economically possible to clean to such an extent that from but one to 2 per cent of impurities remain.

CRUSHING OF SEED

The cleaned seed is now crushed by passing it back and forth between rolls which are built in stacks of five. They are usually made of chilled steel and are 14 in. diameter by 48 in. long. The journal boxes are loose in vertical guides so that the weight of the other four is carried by the bottom roll. The seed passes between rolls four times and at each successive passage the pressure is increased by the weight of an additional one. The top, middle and bottom rolls are driven by power applied by rope or belt drive as the case may be.

The object of the crushing is to disintegrate the seed, thus breaking down the cell walls preparatory to expression of the oil. Consequently, subdivision to the greatest possible extent consistent with economy is the best practice. Generally all of the rolls travel at the same rate so that there is no grinding or mulling action to assist in the disruption of the seed itself.

Stacks of rolls have been built in which the speed of each varied, thus producing a grinding action by slippage at point of contact. No data are available to show whether or not an increase in yield resulted.

Given a standard set of rolls the two important variables are the revolutions per minute and the rate at which the seed is fed. Practice in both varies. Obviously the more rapid the rate in both instances the poorer the grinding will be. Observations have led to the conclusion that the crushing of about 10½ bushels per hour at a roll speed of 150 r.p.m. is the most economical practice on rolls 14 x 48 in.

TEMPERING OR HEATING OF LINSEED MEAL

In order that, when placed under pressure, the ground seed may more quickly, more easily and more completely give up the oil it contains, it is heated with or without the addition of moisture. This is accomplished in the heater or cooker, the unit of which is a cylindrical chamber with a steam jacket on the bottom and around the sides. These cookers vary in diameter from 42 to 84 in. Linseed oil mills are generally equipped with 72 or 84-in. cookers. The depth of the chamber is about 24 in. From two to four units, one above the other are generally used. In each receptacle there is a sweep which lies very close to the bottom in order that the meal may not lodge there and burn. The shaft to which these sweeps are attached is hollow. A finely perforated pipe is fastened to the back of the sweep and is connected to the opening in the shaft. Through this system steam may be admitted to the meal.

There are two practices followed, one in which the two-unit cooker is employed and steam is led into the meal in the upper chamber. The amount of steam varies with the moisture content of the seed. The feed is so regulated that the meal chambers are not full providing space above which allows evaporation to take place.

The other method is to use the "three" or "four" high kettle, adjust the feed so that the whole apparatus is full all of the time and admit no live steam at all except possibly when crushing old, dry seed which is hard to soften.

The factors entering into this operation are the speed of travel of the meal, and consequently time under heat, the temperature to which it is heated, and the amount of moisture present. If the time is too short the tissues are not thoroughly softened and the yield is low as a result.

When the temperature is low the yield falls and the cake is brittle and easily broken; if it be too high the cake has a characteristic and undesirable odor and the oil will be dark and in certain uses will cause trouble.

Too little moisture yields a crumbly non-adherent meal which will not pack well and from which the cake is unsatisfactory. If too wet the meal is soggy, the oil contains an excessive amount of moisture and the cake will be dark in color and tough.

We have, therefore, three factors to coordinate in the tempering or heating of linseed meal. The only means of control are the senses of the operator. He takes a handful of meal and compresses it. If it has a certain "feel" under pressure, packs in a definite manner, and oil can be started by the pressure of the hand, he says that it is well tempered. He modifies one or another of the elements of control, when the cake or the meal varies from his standard.

Obviously the personal equation causes marked fluctuation. No two men are in complete accord upon fundamental principles. No accurate data are available, if indeed any exist, on which to base a system. Little

*A paper read at the Buffalo meeting of the American Institute of Chemical Engineers, June 20, 1917.

is known of what really happens in the tempering operation. The theory is that the combined heat and moisture break down the walls of the oil cells, coagulate the albuminous sediment forming portions of the seed and reduce the viscosity of the oil, thus making it possible for the flow to be more quickly and easily accomplished under pressure.

Of the mechanism of the changes within the ground flax seed, or of the manner in which variations in operation bring about the results noted in practice, little or nothing is known. It does not appear to be a difficult matter to apply scientific methods of observation during the process with the view of securing means of definite and positive control so that variations in raw material may be made convergent in the meal cooker and so that uniform efficiency of extraction and uniform products may result.

THE FORMER

From the bottom of the lowest compartment of the heater the meal passes into a metal box mounted on a runway over which it travels to the "former," a machine which measures the amount of ground seed to constitute the charge for each of the plates of the press and compresses it to a soft cake. These formers are actuated by hydraulic, by steam or by belted power. The hydraulic type, the one commonly used, is operated from the low-pressure hydraulic system.

At the end of the runway on which travels the meal box is a hinged flapper frame on a table which moves at right angles to the travel of the box so that it may be pushed back under the stationary part of the machine. This consists of a head block of heavy cast iron supported by wrought iron pillars, designed to withstand the upward pressure of a base plate actuated from below by a hydraulic ram. During the operation a slide gate in the bottom of the cooker is opened by hand to allow the box to fill with meal. On the table is laid the press cloth in a strip about 15 in. wide and 6 ft. long.

The buggy box is now filled with meal and pulled out over the frame into which most of its contents fall. It is generally given two passages over the frame to insure an even filling of the space. Considerable skill is acquired by experience in the handling of the box in order to produce a clean uniform fill with the material evenly placed and of constant weight. The table is now pushed back under the head block, the power applied for an instant, then released, the table withdrawn and the flapper frame is lifted. The ends of the cloth are thrown over the top of the formed cake when the pressman slips a sheet of iron pan slightly larger than the frame and equipped with a handle on one end under the cloth and transfers the molded and wrapped cake to the press box. This type of former minimizes danger of injury to the operators because it is practically impossible to get one's fingers in a position where they will be crushed.

To do good work a former must mold a perfect and compact cake that will fit the press boxes, must work cleanly, that is, not spread the meal out to litter up the press room, must make a cake sufficiently coherent to permit of necessary handling without loss of portions of it and must deliver a cake of uniform density and thickness so that uneven pressure will not be caused in the press and uniform cakes will result after pressing.

There is a mechanically operated buggy box in which the box is on the end of a piston actuated by hydraulic power. The machine lacks the uniformity resulting from the effort of a man interested in doing good work because it will not run the meal box over the frame twice in order to have it evenly filled and thereby make a cake of uniform density. It doubtless, however, compares favorably with the work of green or indifferent operators. It does not make a reduction in labor expended because a man is required to operate this machine and to do the other work necessary to form and wrap the meal just as when all hand power is employed.

THE PRESS

The press used in the winning of linseed oil is the typical open-plate hydraulic machine, the essential parts of which are: The cylinder and lower block, frequently cast in one piece; a stationary head block which is bolted through to the lower block by means of heavy hammered iron columns; and the ram, on the end of which is placed a platen or heavy block rigid enough to prevent flexure at the ends so that even pressure will be exerted over the entire plate area.

Hydraulic pressure is obtained from power-driven pumps so equipped as to be capable of supplying both high and low pressures. One of the most popular forms of pump is a four-crank design furnishing both pressures. The hydraulic system consists of a supply tank for the liquid, which in this case is linseed oil, pumps, accumulators, valves, change cocks and piping. The accumulator is of heavy material superimposed upon a ram and guided in its vertical movement. Its object is to store hydraulic fluid which is intermittently used, thus producing more constant load on the pumps, to steady the pressure by reducing shocks which, if severe, would injure the machinery and piping, and to act as a regulating valve to maintain a uniform pressure. Both the high-and-low pressure systems have an accumulator. The low pressure is used to start the working stroke of the press and to operate the "former," the packer and possibly the other hydraulic machinery. It is usually set at 500 lb. per square inch. The high pressure varies between 3500 and 4500 lb.

The regulation of the presure is this: When there is no demand for fluid the plungers work idly by circulating the oil through and back to the supply tank by means of the automatic movement of a valve from a system of adjustable rods and levers at the accumulator. When working fluid is again required the by-pass valve is closed by the fall of the accumulator and the pump again delivers fluid at working pressure. When communication is opened to a press through an automatic change cock the pressure is turned onto the ram only from the low-pressure accumulator. The press ram travels up rapidly until a pressure of 200 to 300 lb. is reached, which is enough to start the oil. A choker in each pipe regulates the speed of the press by throttling the flow of the fluid. The ram travel is slowed down in proportion to the escape of the oil. When a pressure of 500 lb. is reached the oil from the high-pressure accumulator is automatically turned on to the press ram. The speed of travel is again governed by a choker so that the maximum pressure of about 4000 lb. is not reached until the ram is nearly at the end of its travel.

Press plates are at present generally made of rolled steel about ⅝ in. thick. They were formerly made of iron or of brass. The sizes of the plates vary, although in linseed oil manufacture they are generally designed to hold a cake 13 x 32 in. or 16 x 34 in.

Drainage is secured by cutting grooves or oil channels close to the edges of the plate which are pitched toward the rear where they connect with down spouts that conduct the oil to the receiving troughs at the floor level behind the presses. Some presses are tilted back to give a fall sufficient to cause the oil to run in that direction.

Suspension of the plates, when pressure is released, is usually obtained by the use of links, each set of which carries the plates beneath, unless sectional supports are provided. The links are of two sorts, the plain open type, or the square, flat-headed type. The former are fastened to T-headed bolts screwed onto the edges of the plates while the others are slipped into notches out in the sides of the plate near the ends. Often the plates are divided into groups so as to lighten the load upon the links. This is accomplished by having lugs on the plates which engage the heads of screws set at proper intervals in the columns.

Another very effective method of support is by a step ladder or inverted V-shaped device the feet of which are fastened into the columns near the bottom plate, while the top is attached to the head block at the center of each side. The legs of the ladder are of steel plate and are notched at measured intervals.

Into each side of a plate are screwed two headless bolts so placed that each engages its own step of the ladder. Thus, each plate is supported by a rigid frame and the load caused by a group of plates is done away with. The wear on the steps is slight and easily adjusted, for when the press is up the supporting frame can be removed and repaired without removing the plates, while when the links are used each plate must be removed whenever it is necessary to shorten them.

It is important that the links be kept true, for they control the space between plates which must not fall below a minimum or the cakes cannot be placed easily. It is a too frequent occurrence, especially in new mills, to have the cake space shortened by wear or lengthening of the links so that the bottom cake is not easily put into proper position causing uneven pressure and the breaking of the platen. It is false economy to reduce the cake space in designing a press, for time is lost during loading and cakes are not evenly placed causing them to lie at angles instead of parallel to each other. This means uneven pressure and loss of oil. With ample working space the molded and wrapped cake is quickly placed into proper position, thus lengthening the time of pressure and insuring even pressure throughout.

CAPACITY OF PRESSES

Primarily the capacity of the press is controlled by the number of plates comprising it, though variations in operation, to be discussed later, are factors of the capacity of any given press.

The number of plates in the presses of American mills varies, generally between sixteen and twenty-six. The obvious objection to the small presses is low capacity, for when reduced below twenty plates little if any gain in yield results. When the large twenty-four and twenty-six-plate presses are employed it is hard to find men tall enough to reach the top plate and agile enough to place the bottom one quickly. A slight additional expense is noted with large presses caused by the destruction of the ends of the slip pans which are broken by the exertion of downward pressure before they are entirely out from between the plates.

When a large number of cakes are replaced the press is down a longer time and consequently cooled more. The temperature of the press and its contents has an important bearing upon the yield, consequently the lower it drops the lower is the extraction. It may be said that the meal can be raised to a higher temperature, but this is an undesirable thing to do for there is a limit beyond which meal ought never to be heated.

Further, when the number of plates is large, there is a correspondingly great mass through which the pressure must be exerted. When this goes beyond a maximum excessive cushioning occurs and low yield results. The extent of the loss caused by the use of large presses is an unanswered question, though one capable of easy solution.

No data are available which show, with all other variables constant, the effect that the increase in the number of plates has upon the yield of oil. What might be called circumstantial evidence—that is, the comparison of the percentages of oil in the cakes produced in mills known to have large and small presses—shows the latter to be more efficient. However, other factors enter which could account for the difference. It is the opinion of many versed in the operation of linseed mills that the twenty-plate press combines the greatest number of elements that make for efficient extraction.

PRESS MATS

A much mooted subject in linseed oil manufacture is that of press mats. These are mats woven from rope of coarse hair such as that from the manes and tails of cattle. They are fastened to the plates, which are often roughened to prevent slippage. Frequently the mats are attached to a screen of coarse mesh and heavy wire, which are in turn made fast to the plate. Mats of malleable iron are also used, which are bolted to the plate. In many mills mats are used on both top and bottom plate; in others on but one, and in still others none at all are used.

The statement has been made that the mat was originally used to form a porous material through which the oil could run after leaving the meal. Practice, however, has proved that the presence or absence of mats makes no difference with the flow of oil.

Supporters of the use of mats now claim that they tend to make the transmission of pressure equal at all points. If properly molded, the cakes will lie evenly on the plate and consequently be subjected to an even pressure without the assistance of a mat. It is also hard to see how a mat can even up the exertion of pressure in view of the normal causes of that action.

In answer to the statement that mats rigidly grip the press cloth thus preventing slippage and uneven tension on it, can be placed the experience in two mills which has been directly communicated to the writer. In one there were two sections, one equipped with double hair mats and the other with none. After years of parallel operation the superintendent made the statement that press cloth costs were the same in both cases.

In another mill strips of sheet iron were placed over the mats with a consequent slight reduction in the cost of press cloth.

Hair mats are poor conductors of heat, hence, it is said, the temperature of the meal will be reduced to a lesser extent during the pressing operation, and therefore the yield of oil will be increased. In the previously mentioned mill that section equipped with hair mats produced no more oil than did the bare plate portion.

With only conflicting statements available, and these based upon data doubtless modified by other variables effective during the period of observation, it is impossible to state positively what the hair mat does or does not accomplish. The objection to their use is cost. They are expensive and need frequently to be replaced.

The mat does serve to guide the slip pan into proper position when the soft cake is slipped in between the plates, thus insuring equal pressure and parallel plates. The malleable mat accomplishes this without expenses save the initial cost. When bare plates are used they are corrugated or cut at right angles to prevent slippage while under pressure.

Another objection to mats is that they are thick enough appreciably to reduce the cake space in a given column height. When bare plates are used there are fastened along the sides near the edge strips of metal beveled on the inside. These are to serve as guides in filling the press and also to prevent the meal from being pressed out at the edges. If they are made high enough effectively to guide the pan they cut the press cloth.

THE PRESS CLOTH

One of the relatively large items of expense in linseed oil manufacture is that of press cloth; that is, the material which is wrapped about the cake when molded. It is usually woven from camel's hair because of the elasticity of that fiber and its ability to retain its strength and form under high pressures and temperatures. At present, this material is very high in price and is scarce as well. Various mats of wool and mixtures of wool and camel's hair cloth are being tried, but preference would still be given to the camel's hair. Press cloth of human hair is now available. First tests of this showed up very well against camel's hair.

The avoidance of those elements of press room practice which make for the rapid destruction of press cloth is essential to good work. Trouble can start in the heater for water balls, or an uneven heating or wetting of the ground seed will gum up the cloths in spots, thus preventing the flow of the oil through them and causing disruption at that point. Meal not uniformly temperated does not pack evenly, producing tension on the cloth. If too much moisture is in the meal as molded it forces its way into the cloth, fills up the interstices with consequent tension and tearing. Too high a temperature will reduce the tensile strength of the fibers and breaking will result.

If the "former" does not produce a cake of uniform density the uneven packing in the press causes stresses which result in torn cloth. The press room foreman must watch the rate of ram travel after the oil begins to flow, for if it is too fast the volume of oil set free, much of which passes to the edges through the cloth, will tear it. This must be watched with extreme care when the pressing takes place at a low temperature as in starting up after a shut-down.

The torn cloths are darned, patched, mended and pieced until the waste comprises short strips which are beyond redemption. These are but typical causes for too rapid destruction of press cloth. Constant watching by intelligent men is necessary to keep down this item of expense.

THE FUNCTION OF THE PRESSURE, CAKE WEIGHT AND TIME

In the pressing of the tempered meal in a given press there are three variables which are functions of yield and capacity; one is the pressure. That most generally used is from 3500 to 4500 lb. per square inch. A gage should be placed on each press so that close watch can be kept for unexpected variations.

Another variable is the weight of the molded cake. Practice varies between those weighing 10 lb. after pressing and those of 15 or 16 lb. When the cakes are thick the mass of meal under pressure is great, there is more tendency toward uneven packing and the cushioning in the press is at a maximum.

As in the case of the number of plates in a press there are no authentic data available on the effect of variations in the cake weight upon oil yield, and so again we draw our conclusions from the analysis of light and heavy cake without knowing that weight was the only variable. The light cake gives the lowest average oil content. The minimum weight produced is 10 lb. To keep as close to that as possible is a good practice.

The third variable is time. The presses are usually arranged in groups of six, one of which is operated by the two or three men who work together. Assuming such to be the case the pressings per hour are expressed as six on six, seven on six or five on six, as the case may be.

In the first case the pressure is exerted for sixty minutes less the time required to discharge and charge, which varies between five and ten minutes with the dexterity of the men. The seven on six method allows but fifty-one minutes, while five on six permits of seventy-two minutes under pressure less changing time.

In a mill which operated six on six part of the year and seven on six the remainder, a careful analysis of the cake produced is always kept. A tabulation for a period of several years showed that the longer time increased the oil in the cake by one-half of 1 per cent. With cake at $30 per ton and oil at 50 cents per gallon, ½ per cent reduction in the oil content of the cake makes a gain of 2.5 cents per bushel of seed, or $3.25 per press per day when it is run for yield and not capacity. To-day the figure would be about 9 cents per bushel.

As a result of a study of the data on hand supplemented by experience the writer would use, with the feeling that he was not far from the most economic practice, one roll for each two presses, an 84-in., three-high heater for twelve presses, or possibly a 72-in. to six presses, a hand-operated hydraulic former and twenty-plate presses in which 10-lb. cake would be produced at the rate of six pressings per hour on each six presses.

The obvious conclusion to be drawn from the statements made is that the manufacture of linseed oil is controlled in an uncertain empirical manner. It is possible that a system could be worked out by accurate

observations of the effect of various changes in operation and by a scientific study of the underlying reactions and mechanical principles involved which would minimize the effect of variations in the seed and thus render extraction more efficient. With the present and probable prices of oil and cake for the near future one would not have to make much of an improvement to pay large dividends upon the investment required.

DISPOSING OF THE CAKES

When the cakes are removed from the press they are stripped—that is, the wrappers are removed. This is done either by hand or by machine. It is hard, disagreeable work, for at the start the pull is mostly on the fingers and the cake is hot. The mechanical strippers in use simply catch the end of the cloth when it is placed in contact with a revolving shaft about which it is wound.

The stripped cake is now sent to the trimmer, where the soft edges of high-oil content are cut off. Trimmers are of two types, those with revolving knives and those with stationary knives, both having spring tension devices. There is little choice in effectiveness. The rotary knife takes more power and is more complex, but the trimmings from it do not need regrinding, while those from the stationary knife machine do.

The depth to which to trim depends upon local conditions. It should be determined at each plant from its operating cost so that the yield of oil from the trimmings when recrushed will be enough to repay the expense of handling. If trimmed too deep the oil content will be so low that the oil recovered will cost more than it is worth, while if too much oil is left in the cake by shallow trimming oil loss results. About 12 per cent oil in the trimmings is right when normal conditions obtain.

If to be sold as such, the cakes are packed generally in second-hand sugar bags and shipped. A hydraulic machine takes a pile of cake from the trimmer and pushes it into a bag, which is loosely filled, then the bag is placed under a packer which jams single cakes into it until the strain is near the breaking point.

When ground to meal the cakes are run into an impact mill direct or into a breaker and then an attrition mill. The first method is generally considered the more economical.

THE OIL

When the oil runs from the presses it is caught in settling troughs or deep metal boxes in which coarse particles settle to the bottom. From here it goes to filter supply tanks. Filtration is accomplished by the plate and frame press. The filter medium varies from light sheeting to heavy duck and from light to heavy paper. At some mills the oil is filtered warm through cloth, sent to storage and then refiltered just previous to shipment. With many the second filtration is omitted. Others allow the oil to cool without the first, or, as it is termed, "scalping," filtration, and then pass through cloth or paper.

Any one of these practices will remove the suspended particles of seed and deliver a clear oil. However, moisture and materials taken into colloidal solution from the seed are present in larger amounts in warm oil. They gradually precipitate as the temperature falls forming what is known in oil parlance as "foots." Therefore the temperature of the oil at time of filtratin is an important function of its quality. If single filtration is determined upon, excellent results may be had by allowing the oil to cool and then passing it through cloth or paper, preferably the latter.

The quality of raw linseed oil is obviously dependent upon the manner of its filtration. Further, too high a temperature in the heater darkens the oil and causes it to dissolve more material from the seed. A hot pressed oil will darken more under heat, will not bleach so well in the refinery and shows other deleterious effects of the high temperature.

The quality and cleanness of the seed have a marked influence as well. Seed selection for oil quality is unknown, because no means at present exists to connect the characteristics of perfect flax seed with the quality of oil contained.

An investigation of this problem is at present under way. We are hopeful of results that will enlighten us upon the effect of seed strain, soil and climatic conditions, upon the quality of oil and possibly enable prediction from an examination of flax seed of the quality of its oil.

The manufacturers employing linseed oil demand of that product specific qualities such as pale color, high content of fatty acids, proper action in the varnish kettle and high speed of polymerization when subjected to high temperatures. These qualities are imparted by chemical treatments of various sorts which are more or less secret and which involve only simple mechanical equipment and operation.

During the last five years the average oil content of clean seed received by a mill on the seaboard was 39.02 per cent. North American seed comprised 75 per cent of that crushed, the rest being South American. Assuming that the cake will contain 5.5 per cent, an amount attainable by good practice, the theoretical yield of a cake will be 36.15 lb. and of oil 19.86 lb., or 2.64 gal. of 7½ lb. each. The word "theoretical" is used because there is a manufacturing loss of about 2 per cent. This is nearly all due to the evaporation of moisture, though some is accounted for by soakage, dusting and similar causes. If the moisture in the seed is high the loss will be above normal for oil carries very little water, so that the cake must contain all that is in the seed or a loss is inevitable.

Chicago, Ill.

German Alcohol.—At the annual meeting of German spirit manufacturers, recently held in Berlin, it was stated (according to the *Chemical Trade Journal and Chemical Engineer*) that all the departments of the manufacture had been busy with general and special war work. The outlook for the future was not considered favorable, since for years to come potatoes would more than ever be wanted as food; a great many of the large farms used to rely more upon potato-spirit distillation than upon farm produce. For incandescent burners alcohol with 15 per cent of benzene is being utilized; in fuels, alcohol with 25 per cent of benzene is substituted for petroleum. The sale of petroleum for illumination is at present forbidden in Germany. Acetone fermentation works had been opened in Arenberg, but the technical difficulties of the process had not been quite overcome yet; it is also intended to manufacture by fermentation of butyl and other alcohols.

The Recovery of Potash from Beet Sugar House Waste Liquors*

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The recovery of the residual values from beet sugar waste liquor has been the subject of serious investigation even prior to the war. However, the abnormally high potash prices of the past few years have brought about renewed efforts in this direction.

The fundamentals for a consideration of this problem are the following:

During the 1916 season approximately 6,000,000 tons of sugar beets were produced in the United States. In all probability a materially greater tonnage will be produced this year, and the possibilities for increased production in the immediate future are promising, though this phase of the problem is so intimately related to the tariff, the agricultural labor supply, and ruling prices of other agricultural products that prophecy is fruitless.

The composition of the beet, and therefore its content of potash, is variable from season to season and in different localities and soil conditions. The following analyses of beets from three widely separated localities in the United States can serve as a basis.

	Colorado Per Cent	California Per Cent	Wisconsin Per Cent
Moisture	78.36	63.99	74.37
Dry substance	21.64	36.01	25.63
Ash (carbonate)	0.89	0.88	....
Total nitrogen	0.199	0.254	0.1817
Sugar	15.40	25.60	18.7
Mineral matter in per cent in beets:			
Cl	0.102	0.065	0.040
SO_3	0.028	0.034	0.024
P_2O_5	0.046	0.121	0.023
K_2O	0.320	0.269	0.320
Na_2O	0.097	0.106	0.089
CaO	0.022	0.078	0.041
MgO	0.058	0.051	0.047
$Fe_2O_3Al_2O_3$	0.042	0.014	0.027
SiO_2	0.005	0.016	0.036

Both the California and Wisconsin samples were several days in transit to the laboratory at which the analyses were made, and undoubtedly lost considerable moisture by evaporation which consequently increased the percentage content of dry matter. Aside from that the California sample was abnormally high in sugar content.

From an agricultural and economic viewpoint—aside from the sugar—the nitrogen, phosphoric acid and potash content of the sugar beet is of more than passing importance.

Accepting the average of the three analyses herein reported as the average for the entire production, the 6,000,000 ton crop of beets of 1916 contained of

Nitrogen ..... 12,700 tons
Phosphoric anhydride ..... 3,780 tons
Potassium oxide ..... 18,180 tons

Investigations indicate that in extracting the sugar values by the diffusion process approximately 60 per cent of the nitrogen and 90 per cent of the phosphoric acid and potash content are extracted with the sugar and pass into the process, the rest remains with the pulp. As this pulp now is completely utilized for live stock feeding purposes, the plant food values of this pulp are not lost to agriculture except in so far as farm yard manures are inefficiently utilized.

Of the plant food values extracted and now in the juices phosphoric acid is completely eliminated as calcium phosphate, and to date largely wasted. A part of the nitrogen content is eliminated as coagulated protein and otherwise, together with the phosphoric salts. The potash, however, is not eliminated from the juices by the usual processes of purification and is found in the final molasses, that is the mother liquors, from which sugar cannot be further recovered by direct crystallization, and for this the presence of potash salts are partly responsible.

The production of molasses from beets is somewhat variable from season to season, but an average percentage production for the United States will be somewhere between 5.5 per cent to 6.0 per cent on beets. With a 6,000,000-ton crop of beets this totals to 330,000 to 360,000 tons.

A study of a series of thirteen samples of American beet molasses as reported in Volume 18, No. 4, of *Sugar*, indicates an average content of 1.69 per cent nitrogen and 4.66 per cent of potassium oxide, K_2O.

On this basis the beet sugar molasses production of the past campaign contained between 15,400 and 16,700 tons of K_2O, which checks fairly closely with the figures above estimated. Of the total beet molasses production, under normal conditions perhaps 5 per cent, under present conditions double this amount or more, is used in alcohol production and the still residues, containing the potash, are concentrated and usually enter the fertilizer trade and are therefore, not lost to the general economy.

Approximately 40 per cent of the total molasses production is used for stock feeding purposes, in part direct as such, but by far the greater part is mixed with some absorbent feed, frequently beet pulp either fresh or dried, and also many of the fodders. The potash values in this case are recovered in proportion as the manureal values from these feeding operations are recovered.

The remainder of the United States molasses production, perhaps 45 per cent of the total, during the past season from 148,000 to 152,000 tons, is desugarized, that is sugar is extracted in marketable form. It is this portion of the beet crop that contains the possibilities of potash production in commercial form at the sugar factories.

The process now used almost exclusively in this country in extracting sugar from this molasses is known after its inventor as the Steffens precipitation process in which sugar is precipitated as tri-calcium saccharate.

Essentially the procedure is as follows:

Molasses of about 80 per cent solids is diluted to 10 per cent to 12 per cent solid content, cooled to about 15 deg. C. and under suitable means for cooling and stirring, finely powdered calcium oxide is dusted into the solution. If the conditions essential to the process are adhered to 90 per cent or more of the sugar is precipitated as a calcium compound and is removed from the mixture by filtration.

The filtrate, now with a content of solid matter of 5 per cent to 7 per cent contains practically all of the potash originally in the molasses and also variable percentages of sugar not precipitated above.

The sugar in solution is probably present in the form of dicalcium saccharate $C_{12}H_{22}O_{11}\cdot 2CaO$. If this cold filtrate is heated to 85 deg. C. approximately 60 per cent of the sugar in solution is precipitated as a calcium saccharate probably according to the following reaction:

*A paper presented at the Buffalo meeting of The American Institute of Chemical Engineers, June 22, 1917.

$$3C_{12}H_{22}O_{11}\cdot 2CaO \leftrightarrows 2C_{12}H_{22}O_{11}\cdot 3CaO + C_{12}H_{22}O_{11}.$$

The reaction is reversible and on cooling the saccharate formed dissolves. It is necessary to filter at the precipitation temperature.

This, known as the hot saccharate process, is now quite generally used to recover additional sugar values from the solution which are not readily and economically recovered by the first step or cold process.

The filtrate, now known as Steffens hot waste water, still contains from a few hundredths to four or five tenths of a per cent of sugar, some lime and practically all of the potash and most of the other non-sugars present in the molasses. This is the waste liquor forming a potential potash supply.

In several instances, where the sugar company controls agricultural lands in quantity adjoining the factory, these waste liquors, together with other residues, are used to irrigate the lands. This is perhaps the most economical method of utilizing the residual values as all of the potash and phosphoric acid and nearly all of the nitrogen of the beet can be returned to the soils, but this is practical only in isolated instances, and only about 8 per cent of the total beet crop is handled in this manner.

In still other of the irrigated sections where the residual waters are discharged into existing streams and the streams are subsequently diverted for irrigation purposes some of the values may be inadvertently utilized, but in any event the losses to the economy of the state must be very considerable by this method of disposal.

In most cases the waste residues are sent into settling basins, the clear effluent of which reaches the streams and is carried away. Efforts had been made even before the war to recover these values, and owing to the stimulus of high potash prices of recent years the work in this direction has been followed with more than usual vigor. However, the problem has its difficulties.

The hot waste water as produced is very dilute containing 96 per cent or more of water, it is necessary to concentrate it. As produced it contains 0.2 to 0.5 per cent of free lime, CaO, which will foul the evaporating surfaces if not removed. This is readily enough accomplished by carbonating (injecting CO_2 gas) and filtering. (It might be stated that during the past campaign in one case these waters were concentrated by the direct gases from an oil fire passing upward through a sheet metal gradier over which the waste liquors flowed. In this case removal of the lime was not necessary as the heat transfer was brought about by direct contact without an intervening metallic surface. This method of evaporating is prohibitive as to costs under normal conditions.)

The carbonated and filtered waste water varies in composition with the season, locality, and factory practice, but the following is typical.

	Per Cent
Moisture	97.00
Dry substance	3.00
Carbonate ash	1.00
Sugar	0.30
Organic non-sugar	1.70
Nitrogen	0.16
K_2O	0.35

This indicates at once that the content of values is low, the cost of evaporation comparatively great, and also that under normal conditions, when the value of a unit of nitrogen is two or three times that of a unit of potash, the nitrogen values are as great or greater than those of the potash contained in these waters. Up to a content of 50 per cent to 55 per cent dry substance this water can be readily enough concentrated in multiple-effect evaporators, and quadruple and also quintuple-effect evaporators have been used very successfully. With a content of more than 55 per cent dry matter the liquor begins to salt out and foul the heating surfaces. However, beyond this point the material can be readily enough concentrated still further, and brought to a dry state by the use of one of the various types of vacuum drum dryers. The trouble is to keep the material dry.

The dried material containing 10 to 12 per cent of K_2O and 5 per cent N. is so exceedingly deliquescent and absorbs atmospheric moisture so readily that it becomes fluid in a very short time.

Various absorbents have been used to overcome this difficulty, one of the most successful being dried slaughter house wastes which incidentally are deficient in potash, so the two materials complement one another. Ultimately this may prove to be a direction in which considerable quantities of the sugar factory waste waters will be utilized, but unfortunately only few beet sugar factories are now located within a reasonable distance of the meat packers and the cost of freight enters.

In some localities small quantities of 50 to 55 per cent dry substance have been disposed of in tank car lots directly to the agricultural industry as a liquid fertilizer. In other instances it is urged to sell the liquid fertilizer direct to the farmer, the farmer to saturate his barn yard manure with the concentrate and thus use it. It is doubtful whether material quantities can be disposed of in this form at present.

With present potash prices the nitrogen values have lost their relative value with the result that in at least one instance these have been sacrificed in order to obtain a product comparatively high in potash content, which would permit its shipment considerable distances to the potash-consuming centers.

When the Steffens water is concentrated to about 55 per cent dry substance owing to its high content of sugar, and other organic matter, it can be quite readily ignited and charred, its own content of combustible matter then furnishing most of the necessary heat. The char, or crude ash thus produced contains from 30 to 35 per cent of potassium oxide, but only traces of nitrogen. This procedure is economically justifiable only with present potash prices. In other directions experiments are being made toward a recovery of the potash salts in comparatively pure form, and still save the nitrogen values.

That roughly covers the efforts made in the recovery of the values of the beet sugar liquor residues.

Technically the recovery of the potash values from these liquors is a comparatively simple and perfectly feasible problem. It is simply one of evaporating the dilute liquors as economically as practical, charring the residue to produce the crude ash and leaching and recrystallizing if this is desired. The quantities of water to be evaporated, however, are large, the necessary equipment costly, and commercially such a procedure has possibilities only during war prices.

Now it is true that almost any sugar factory could have paid for a potash recovery plant in one year with present potash prices, but the war may end any time and leave a lot of very costly equipment on hand, es-

pecially as the cost of such equipment, evaporators, boilers, etc., is abnormally high at present. Then also a beet sugar factory operates seasonally only, the average length of the operating season is only about 100 days, and the earnings must be made during this short period. But at that some progress is being made, and at least one concentrating plant is under construction and several others under consideration and more of the values will be recovered during the 1917 campaign than during the past.

However, in these instances a recovery of all the values in the liquors is aimed at, not the potash values only. This will be touched briefly below.

Approximately the disposition of the potash in the sugar beet crop grown in the United States at present is as follows:

Returned to farms in pulp.....10 per cent
Found in molasses produced.....90 per cent

The potash found in molasses is distributed as follows:

To alcohol plants.....10 per cent plus
Used as molasses feeds.....40 per cent plus
Desugarized .....45 per cent plus

This only leaves under control of the manufacturers about 40 per cent of the potash content of the beet which on the basis of a 6,000,000-ton crop amounts to between 6800 and 7500 tons of K_2O.

This quantity is now disposed of as follows:

Directly to the soil as factory sewage..20 per cent
Concentrated to 50-55 per cent dry substance and sold to fertilizer factories 5 per cent
Concentrated and calcined to a crude ash ..... 5 per cent
Discharged into streams and representing the stock of values now lost.....70 per cent

Thus far the subject has been considered from the angle of recovering the potash for the chemical industries or the potash and nitrogen as fertilizers only. That does not by any means exhaust the possibilities. Beet sugar molasses and therefore the waste water contains a great number of substances which in themselves are valuable or may serve as the mother substance for valuable product. The possibilities can here be touched on only very briefly.

Even in the case of potash and nitrogen it appears from the experience of Europe that the general economy is served best by combining these into a more valuable product. From Germany it is reported that by the Bueb process of destructive distillation the waste liquor of molasses desugarizing processes operating by the strontium process, in that country, produce annually 5000 tons of potassium cyanide and 5000 tons of ammonium sulfate. Steffens waters can be similarly utilized and a United States patent has been granted for such a process.

The molasses waste liquors contain a whole series of organic acids valuable to industry which can be recovered.

The nitrogen of these waste liquors occurs in various forms, partly as a plant basis of which the principal is betain, which has found some application in medicine. A large part of the nitrogen content exists in the form of amido acids. These it has been shown by Effront can, by suitable fermentation processes, be split into ammonia and a mixture of volatile fatty acids, acetic, propionic, butyric. Recent investigations in this country indicate that a mixture of the high boiling point ketones valuable in cellulose technology, can be prepared from this liquor.

Ehrlich insists that the amido compounds present in considerable quantities in beet molasses waste liquors are the mother substance of fusel oil, more particularly amyl alcohol, and suggests extracting these compounds and utilizing them to increase the fusel oil production. This indicates only a few of the possibilities. While it is not claimed that beet molasses may yet prove another coal tar, chemically it may be almost as interesting.

But little has been done in developing the waste liquor values in this country. The reasons are various. Not the least lies in the fact that sugar is a sort of national and international political football. Between duties, bounties, premiums, special international agreements as the Brussels Conference, and competition with the tropics, the beet sugar industry in the United States has never felt sufficiently safe to venture into new directions.

At the outbreak of the present war the outlook was particularly dark. The tariff had been lowered, and a duty free sugar clause enacted to go into effect May 1, 1916. Fortunately, this latter clause was repealed before going into effect.

What the development of the future may be will depend more upon legislation following cessation of hostilities rather than present high prices, and in this respect the beet sugar industry is not differently situated than most other chemical industries in this country.

American Beet Sugar Co.,
Rocky Ford, Col

Metallurgical Processes in the Foundry*

Use of Ferromanganese, Ferrosilicon, Chills and Iron Molds

By Alexander E. Outerbridge, Jr.
Metallurgist, William Sellers & Co., Inc., Philadelphia, Pa.

Before proceeding to the subject proper of my paper I wish to make a little confession. After almost a lifetime spent in the study and daily practical application of investigations in metallurgy on a somewhat large scale, more particularly in cast iron in industrial works, I feel sometimes that I know less about the subject to-day than I thought I did nearly 40 years ago. This is not surprising, however, for I believe it is the universal experience of investigators that the more one delves into Nature's mysteries the more one finds to discover, thus relatively, the more one studies the less one feels that he knows.

The history of the study of astronomy affords, for example, a striking illustration of this. Long before Galileo pointed the first telescope at the heavens, in 1609, the old monks had, with infinite pains, mapped out the firmament and recorded the positions of all the stars then visible to the eye of man and they naturally thought that their charts were complete. But the moment the new and more powerful eye of the telescope was pointed at the blue vault hundreds of thousands of starry worlds came into view whose existence had never before been suspected, revealing glowing stars so far distant that the light from them must have started on its long journey centuries before the Christian era.

*An address delivered before the Philadelphia Foundrymen's Association on June 6, 1917.

So it is with more mundane affairs, such as the study of the composition and physical properties of metals and alloys. Chemistry has told us pretty well the elements and proportions of the components of complex alloys, like cast iron, but that is, after all, a very dim light to guide us and it only reveals a few of the most conspicuous properties, leaving many others yet to be discovered by those who come after us.

In comparatively recent years the microscope has supplemented chemical analysis and has given us much valuable information regarding the effect of heat treatment upon the structure of metals especially iron and steel. The spectroscope also has shown us the signatures of all metals, written in fine lines of colored lights that cannot be imitated or disguised.

The specific gravity of alloys and the remarkable changes in density that may be effected by heat, as in the case of the extraordinary growth of gray cast iron when subjected to repeated heating and cooling* or the equally remarkable change in density caused by sudden cooling from the liquid to the solid state, as shown in the tread or periphery of a chilled cast iron car wheel are subjects of great interest for study. These are but a few of the aids to the study of metals now available and a vast unexplored field yet remains for the future investigator.

The difference between wrought iron, steel and cast iron, is commonly attributed mainly to the proportion of carbon, silicon, sulphur, phosphorus, manganese, together with a few other elements, composing these alloys, and the analytical chemist has no difficulty in determining the relative proportions of these elements with sufficient accuracy, but beyond this lies a region of which he knows nothing. He does tell us, it is true, that carbon exists in iron in two different forms, "combined" and "graphitic," but how many other forms of carbon may there be united with these other elements?

Take pure carbon alone, we already know of no less than three totally different forms, viz.: (1) A soft, intensely black substance called "lamp black" which the chemist tells us is 100 per cent carbon; (2) An intensely hard transparent crystal, the diamond, also 100 per cent carbon; (3) Pure plumbago or graphite, an unctuous material, quite different from the other forms, also 100 per cent carbon. There is absolutely no chemical difference between them.

In like manner it is known that pure silicon exists in three distinct forms or amorphous conditions. So it is with some and probably all of the other elements combined with iron.

The chemist or physicist is not yet born who can, by any known methods of investigation, state with positiveness—or even guess at—the various possible forms or combinations of the elements composing these alloys and it is not, therefore, surprising, that oftentimes the analyses of two specimens of iron, steel or other metals, will be nearly alike, when the physical properties are very different.

*Two bars of gray cast iron were shown that were cast in one mold from one ladle and were both originally the same size, viz., 14 13/16 x 1 x 1 in. The specific gravity of the metal was 7.21, making 450 lb. to the cubic foot. One bar had been permanently expanded or caused to "grow" while in the solid form to 16¼ x 1⅛ x 1⅛ in., making an increase of 40 97/100 per cent. The specific gravity of the expanded bar is 5.54, making 350 lb. to the cubic foot. These identical bars were first shown before this association in 1903. Other bars of gray cast iron have been caused to increase in cubical dimensions over 50 per cent by repeated heating and cooling, still retaining their metallic qualities.

These are a few of the problems I have been studying for nearly forty years, but you are, of course, interested mainly in the practical side of such questions, hence we will now descend from the realm of theory to that of practice.

A number of cast iron test pieces made to illustrate an address given by myself before the Franklin Institute in 1888 on "The Relation Between the Physical Properties and Chemical Constituents of Pig Iron" are shown in Fig. 1. Here are shown test pieces cast

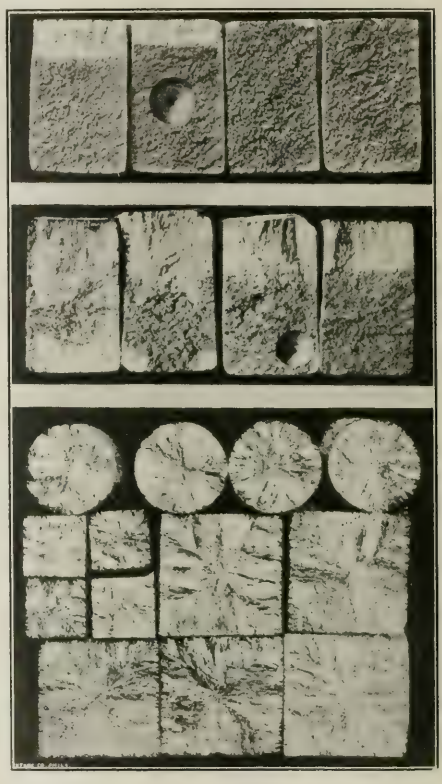


FIG. 1—TEST PIECES CAST IN SAND AND IRON MOLDS

from eight different melts of iron. The two upper rows were poured in green sand molds having an iron chill block on one face.

The test bar at the right hand upper corner shows merely a "skin chill' on the part cast against the iron block, the next bar shows a very little more chill, the other bars show increasing proportion of white iron on the upper faces and two show white iron on the lower faces also. Beneath the eight test pieces cast in sand, you see nine square and four round test pieces, all perfectly white iron, showing very clearly that the crystals are always formed at right angles to the surface of the mold. These test pieces were cast in iron molds from the same ladles of iron as the other bars and you will notice that all are equally white, notwithstanding the fact that the bars cast in sand with an iron chill block on one face vary enormously in depth of chill.

These iron molds may be called "chill magnifiers." I

have used similar chill cups daily for detecting chilling properties in soft foundry irons for over thirty years, and they have proved to be of the greatest value in detecting chill that would not otherwise be suspected in such iron mixtures.

The main difference in composition of the eight melts of iron shown in this plate was found to be in the relative proportion of silicon.

The test piece showing a mere trace of chill has over 1½ per cent silicon, the one showing the most chill has about 6/10 of 1 per cent silicon, the other test pieces contain silicon ranging between these extremes.

The manufacture of chilled cast iron car wheels, (Fig. 2) a purely American invention, to which the development of railways in this country may be said to owe its rapid progress in the early days and to which it is still largely indebted for freight traffic, was rendered possible by the practical application of the chilling property found in our cold blast charcoal irons, and its continued success to-day is dependent largely upon the skill of the chemist to simulate those natural qualities by other means, long after cold blast charcoal iron has gone out of existence.

My first investigation of this peculiar property of cold blast charcoal iron (and of some grades of anthracite and coke iron) dates back to the year 1876, when a fine exhibit of chilled cast iron car wheels at the Centennial Exhibition first attracted my attention. One of the wheels was broken to show the fracture; the plate and brackets were dark gray, while the tread of the wheel was white as silver. On inquiry I learned that the white iron tread was formed by sudden cooling of the metal cast against a heavy iron "chill ring" and that while the plate and hub of the wheel cast in a green sand mold were quite soft the tread was hard as steel.

At that time I was making some specific gravity determinations of various metals in the assay laboratory of the mint, where I was an assistant, and samples of the white iron forming the tread of a wheel and of the dark gray iron forming the body were furnished to me for examination. I was astonished to find that the white metal weighed about 60 lb. to the cu. ft. more than the gray iron portion of the same casting.

This served to explain the abnormal cooling strains in a chilled casting of this character, necessitating prolonged annealing, or very slow cooling, to enable the molecules to adjust themselves gradually and thus relieve the strains.

These investigations led to others and for a period of eight years I was daily engaged in the study of the metallurgy of chilled cast iron car wheels and their manufacture. It was customary to cast, each day, in the car wheel works where I was engaged as metallurgist, a large variety of chilled car wheels ranging from full size, double-plate passenger and freight wheels, 33 in. diameter, street car wheels (usually of spoke pattern) down to small and light mine car wheels.

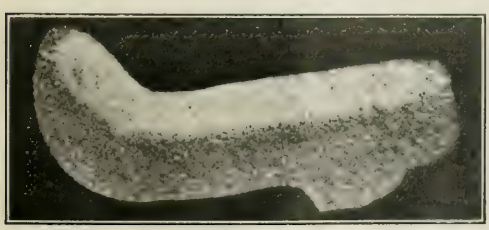


FIG. 2—SECTION OF 33-INCH CAR WHEEL CAST FROM TREATED IRON SHOWING FINE WHITE CRYSTALS AND DARK GRAY

It was not possible to pour all of these from one mixture of iron for the metal suitable for the heavy wheels was too high chilling for the smaller wheels. This necessitated melting soft iron every day in a small cupola to mix in varying proportions with the regular iron in separate ladles.

To overcome this expense, if possible, by altering the character of the iron in individual ladles, after delivery from the cupola, a great many experiments were made (1880-4) with aluminium (then costing $8 per pound), spiegeleisen and 80 per cent ferromanganese, granulated or powdered, added in small quantity to the metal in the ladles.

The effects produced by aluminium and spiegeleisen were in the right direction though they were not sufficiently marked to be valuable but it was then found that when powdered 80 per cent ferromanganese was added in the proportion of 1 lb. to 600 lb. of iron in a ladle, a most remarkable change was immediately produced in the character of the molten iron in the ladle. The first publication of these experiments was given in the address already alluded to, printed in the Journal of the Franklin Institute, March, 1888, and was as follows:

"A remarkable effect is produced upon the character of hard iron (i.e., high chilling iron) by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered 80 per cent ferromanganese, say 1 lb. in 600 lb. of iron. The result of several hundred carefully conducted experiments which I have made enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent, the shrinkage is decreased from 20 to 30 per cent and the depth of the chill is decreased about 25 per cent, while one-half of the combined carbon is changed into free carbon."

Prior to this time manganese had always been regarded as a hardening element in cast iron, and the surprising claim that when added in a ladle of high-chilling car-wheel iron it had an opposite effect at first met with incredulity, but in course of time its use became almost universal, and I believe it still is used very largely in the manufacture of chilled cast-iron car wheels. No application for patent rights was made for this process.

Ferromanganese, when added in powdered form to a ladle of molten car-wheel iron, acts as a deoxidizing and desulphurizing flux by reason of the strong affinity of manganese for oxygen and sulphur, but it is only efficacious when added to iron that is comparatively low in silicon (less than 1 per cent) and high in combined carbon.

It is absolutely useless, if not positively harmful, when added to foundry mixtures carrying over 1 per cent silicon and but little combined carbon, yet I know that 80 per cent ferromanganese has been sold to foundrymen for treatment of their foundry iron mixtures during the time when the alloy could be bought for a few cents a pound. Its present price is prohibitive, except for special purposes.

The use of ferromanganese as a flux in ladles in car

wheel manufacture is of enormous value to that industry, its abuse through ignorance or failure to understand its proper functions must have led to disappointment when added as a flux in ladles of foundry iron by those who do not understand or appreciate the radical difference between car-wheel iron and foundry iron, whether soft or hard.

While the manufacture of chilled cast-iron car wheels requires very accurate control of the chilling property of the metal, it is of far more uniform character than the iron needed for the great variety of castings, ranging from a few pounds up to perhaps 30 tons or over that must be melted often in one day in the large machine tool works with which I am connected as metallurgist. It is customary, therefore, to group all the small work needing soft ductile iron so that it will be cast near the beginning of the run of iron from the cupola, this is followed by a medium grade of iron for miscellaneous castings capable of being machined readily, but not too soft to give good wearing service; this again is followed by strong iron mixtures intended for large and heavy work requiring metal of high tensile and transverse strength.

The importance of having some simple, cheap and reliable method of changing the physical properties of molten iron after it has been tapped from the cupola has been regarded as a desideratum ever since the value of the method of modifying the chilling property of car-wheel iron in individual ladles by treatment with powdered ferromanganese became well known. This led, as I have stated, to improper use of ferromanganese in ladles of foundry iron through ignorance of its proper functions.

As long ago as 1880 I made efforts in this direction with alloys of iron and silicon, but at that time the richest alloy obtainable contained less than 20 per cent silicon.

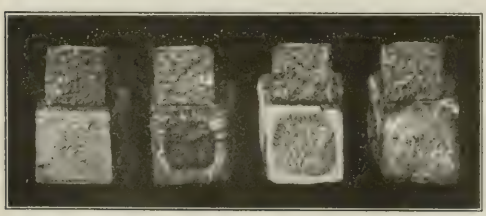
In later years, 50 per cent ferrosilicon was produced in electric furnaces for use in steel making, and these tests were then renewed with the results that have been already published, showing that the addition of a small quantity of the powdered 50 per cent ferrosilicon alloy in a ladle of molten foundry iron produces a remarkable effect upon it by softening and at the same time strengthening the iron. This is quite an opposite effect to that produced by increasing silicon in the cupola, which always tends to weaken iron.

The following table shows the results of a few tests of this kind made in 1905 with ordinary foundry irons (Table I):

The effect of adding 4 oz. of powdered 50 per cent ferrosilicon in a hand ladle holding about 25 lb. of molten iron, and of adding 1 lb. to 200 lb. of iron in a ladle, upon the strength and deflection, as compared with the same iron untreated, is clearly shown in this table. The success of these initial tests led to more extended investigations.

TABLE I.—RESULTS OF TESTS OF FERRO-SILICON IN LADLES

Date	Remarks per Cent Si	Breaking Strain (Lbs.)	Deflection (In.)	Resilience	Shrinkage (In.)	Per Cent Gain: Breaking Strain	Per Cent Gain: Deflection	Per Cent Gain: Resilience
Oct. 10, '05	¼ lb Hand	2265	.120	45.30	.192			
	Ladle	2155	.112	40.09	.191			
	Gain	110	.008	5.21		5.1%	7.14%	13%
Oct. 11, '05	¼ lb Hand	2215	.137	50.51	.182			
	Ladle	2165	.124	44.60	.185			
	Gain	50	.013	5.91		2.3%	10.4%	13.2%
Oct. 14, '05	¼ lb Hand	2600	.152	65.79	.196			
	Ladle	2055	.116	39.18	.188			
	Gain	545	.036	26.61		26.5%	31%	67%
Oct. 15, '05	¼ lb Hand	2330	.143	55.45	.183			
	Ladle	1893	.110	34.60	.183			
	Gain	437	.033	20.85		23.8%	30%	60.2%
Oct. 16, '05	¼ lb Hand	2210	.124	45.54	.183			
	Ladle	2120	.112	39.44				
	Gain	90	.012	6.10		4.2%	10.7%	15.4%
Nov. 13, '05	1 lb 200 lb	2370	.139	54.76	.186			
	Ladle	2050	.118	40.19	.184			
	Gain	320	.021	14.57		15.6%	17.8%	36.2%
Nov. 21, '05	1 lb 200 lb	2178	.128	46.34	.188			
	Ladle	2000	.119	39.60	.182			
	Gain	178	.009	6.74		8.9%	7.5%	17%



1 2 3 4

FIG. 3.—EFFECT OF ADDING POWDERED FERROSILICON TO LADLE.

Fig. 3 shows the remarkable effect in reducing chill in foundry iron by adding thereto powdered 50 per cent ferrosilicon in different proportions in the ladle, ranging from three to eight-tenths of 1 per cent of silicon.*

No. 1 shows the fracture of two test bars cast from a ladle of untreated iron. The upper piece was cast in green sand, 1 in. x 1 in. x 15-in., and was an ordinary transverse test bar. The lower piece was cast in a heavy iron cup in order to very rapidly cool the metal. The upper test piece is perfectly gray and easy to drill. The lower one is perfectly white and cannot be drilled with an ordinary steel drill.

No. 2 shows the fracture of two similar test bars poured from the same iron after addition of 0.3 per cent of silicon in the form of high-grade ferrosilicon (50 per cent silicon) added in the ladle. Note the marked reduction in depth of chill in the sample cast in the iron cup.

No. 3 shows the fracture of two similar test pieces from the same iron after adding 0.5 per cent silicon in the ladle. The "chill" is still further reduced.

No. 4 shows the fracture of two similar bars from the same iron after adding 0.8 per cent silicon in the same manner. The chill in the sample cast in the iron cup is almost entirely absent.

The samples cast in sand are all perfectly gray, but there is an appreciable difference in the fracture, the treated metal showing softer iron than the untreated sample.

The metal selected for this particular test was comparatively low in silicon, consequently having com-

*"Iron absorbs silicon greedily, uniting with it in all proportions at least up to 30 per cent and apparently the more readily the higher the temperature, absorbing it even at a red heat when imbedded in sand and charcoal. It diminishes the power of iron to combine with carbon * * * thus favoring the formation of graphite during slow cooling. It increases the fusibility and fluidity of iron; it lessens the formation of blow holes; by reducing iron oxide it apparently removes one cause of red shortness; it hinders at high temperatures the oxidation of iron and probably of the elements combined with it."—The Metallurgy of Steel by Henry M. Howe.

paratively high chilling property, but this fact would never be suspected from an examination of the fracture of the test sample cast in sand. Very few practical founders are aware of the large variation in chilling property if their iron, sometimes of presumably similar grades, melted on different days, or even of the wide variations in different portions of one heat.

Here we have, I think, a practical solution of one great difficulty that has heretofore militated against the successful use of permanent iron molds for making castings that must be machined.

A mere "skin chill" not thicker than a piece of tissue paper makes the surface of a casting too hard to machine, but by this simple process the foundry foreman can eliminate the last trace of chill from his metal before pouring it into an iron mold.

For years past more or less encouraging efforts have been made and described in technical journals of methods for making castings in permanent iron molds.

The most ambitious one, perhaps, was the pipe casting process of Mr. Custer at Tacony, a few years ago, for which he obtained several patents. Mr. Custer ingeniously overcame the trouble from skin chill on his castings by turning them out of the molds before the molecules had taken a final set and the intense heat in the body of the casting helped to anneal out any skin chill that might have formed. Mr. Custer failed, unfortunately, to take into due consideration the fact that gray cast iron, of which his molds were made, "grows" or increases in cubical dimensions when repeatedly heated above a certain point and then cooled. This, I am informed, causes such a rapid deterioration of his casting machines that his process proved a failure and has been discontinued.

It will, no doubt, be a great surprise to you to learn that ever since the year 1888 machinable castings have been made in the foundry of Wm. Sellers & Co., Inc., in permanent iron molds and still are being so made. I am, through the courtesy of the president of that company, now permitted to show photographs made for this address of original iron molds, still in use, together with some machinable castings that were made in them years ago. Also large and small molds of more recent manufacture. In fact, more than a hundred permanent iron molds, ranging in weight from a few pounds up to 7000 lb. each, are to be found in use in this foundry.

The main object of casting in iron molds is to secure machinable castings of exceedingly fine grain, free from dirt, sponginess or other defects, while at the same time having marked increase in strength.

The question of relative cost of castings made in permanent iron molds (eliminating the molder entirely), as compared with similar castings made in green sand or in baked sand molds, depends upon the number of machinable castings required to be made from one pattern as well as upon other conditions.

In Fig. 4 is shown a picture of an all-iron mold made in 1903 for a saddle for 36-in. planing machine, also one of the gray iron machinable castings, absolutely free from any skin chill, made in this mold.

This was a difficult casting to obtain free from surface defects on one or the other face, or from draw holes, when made in sand, but when cast in this iron mold they were perfect, and all the saddles subsequently made, until a change was made in design, were cast in this iron mold.

This mold was made fifteen years after my first iron mold for machinable castings was made and used in the foundry of Wm. Sellers & Co., and twenty-three years after the first iron mold was made by me for casting "over-iron" in another foundry, and thereby hangs an amusing tale.

In the year 1880, I suggested to the foreman of the car wheel foundry of A. Whitney & Sons, Philadelphia, with which I had become connected as metallurgist, the idea of casting all the "over-iron" in iron molds instead of in open sand molds, thus giving more room on the foundry floor and avoiding expense of making up a sand pig bed daily.

The foreman exclaimed in alarm, "Why it will be all white iron and when we remelt it with the wheel mixture the next day the wheels will all be too hard. We do use a little white iron sometimes to bring up the chill when the mixture is running down in chill, but this plan would spoil all our calculations."

Nothing but an actual demonstration would convince the man of his error.

Iron pig molds were then ordered to be made and a ton of regular wheel iron cast therein. This iron was, of course, white. On the next day the ton of white iron was remelted in a small cupola without any admixture and cast into test bars, chill test pieces and two test wheels. On the following day, when all of these were broken, instead of being white iron, as the foreman had predicted, there was no appreciable difference found between the castings made from iron that had been chilled white in the iron molds and similar castings made from the same iron cast in sand molds. The result was that no sand pig bed was ever again made in that foundry as long as the works existed.

On coming to the establishment of Wm. Sellers & Co., Inc., in March, 1888, I found the same conditions and immediately substituted iron pig molds, which have been used daily ever since that time.

These iron molds for over-iron anticipated the machine-cast pig iron process now so generally used by many years and naturally led to the next step, namely, making permanent iron molds for castings, as soon as it was found practicable to prevent iron poured in

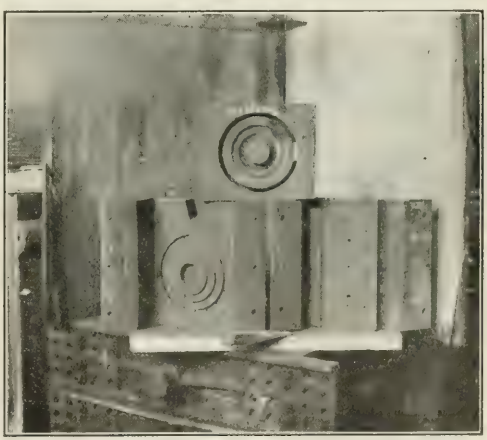


FIG. 4—IRON MOLD FOR SADDLE AND CASTING MADE IN THIS MOLD

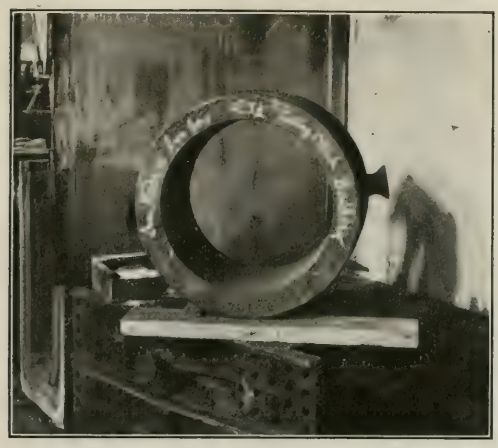


FIG. 5—IRON MOLD FOR LATHE BUSHING

FIG. 7—IRON MOLD AND CORE FOR SPIRAL PINION

them from being too hard to machine without trouble.

Fig. 4 shows an iron mold for "saddle" for 36-in. planing machine and casting made in this mold. The mold was made in 1903. This casting was a difficult one to make in a sand mold so as to get clean surfaces on both sides and free from draw holes. Fig. 5 shows an iron mold for bushing for 42-in. car-wheel lathe. This bushing is 19 in. in diameter, 13½ in. deep and only 1-in. thick. The mold is 6½-in. thick, and there is a collapsible iron core. The metal must be absolutely free from chill as the thin casting is turned inside and outside. Fig. 6 shows an iron mold for friction disks for dynamometer for Pennsylvania Railroad, 42 in. in diameter, cast 1½ in. thick, finished all over ⅞ in. thick. The pull on the draw bar of the locomotive on this machine was originally 80,000 lb., afterward increased to 100,000 lb. It was essential that these cast-iron disks should be fine grained and free from the slightest defects. After failing to procure satisfactory castings in sand molds they were cast in this iron mold and were perfect disks. The casting is poured from bottom. Fig. 7 shows an iron mold and iron core for

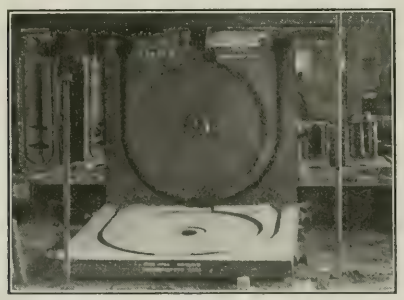


FIG. 6—IRON MOLD FOR FRICTION DISKS

spiral pinion for 36-in. planing machine. Five teeth 2 in. deep are cut from solid metal. "Semi-steel" is cast in this mold, free from chill, and poured from the bottom. Fig. 8 shows an iron mold for "over-pig." The molds were first made in 1880, and this mold has been in constant daily use for many years. On top of mold are two iron molds for "lifting nuts" from cross-head of large boring mills from 10 to 16 ft. These castings must be made of very strong, fine grained iron. Also on top are two test bars originally of the same size, viz., 14 13/16-in. x 1-in. x 1-in. cast in the same mold from one ladle of iron. One bar has been caused to "grow" or increase in size to 16½-in. x 1⅛-in. x 1⅛-in., equivalent to 40 98/100 per cent enlargement.

Anticipating the question, "How do you prevent these molds from warping or growing so as to become useless?" I will say there are two distinct methods. The simplest method and the one we adopt is to make but one casting from one melt in one iron mold. In this way the mold never gets red hot so that it does not grow. The second method is to use low silicon iron for the molds, as metal of that character grows far less when repeatedly heated and cooled above a cherry red

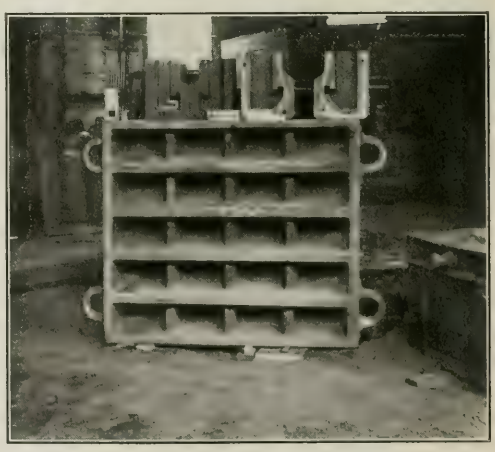


FIG. 8—IRON MOLD FOR OVER-PIG

than does soft foundry iron. Finally, I may say that castings made of white iron do not expand permanently when heated and cooled sufficiently to overcome the original shrinkage of the metal, so that when practicable, permanent iron molds may be made of white iron.

Cutting Oils

Their Properties, Composition, Examination and Industrial Application

By C. W. Copeland

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The industrial chemist is frequently called upon to make an examination of compounded oils which, for want of a better name, are known as cutting oils. While these oils are not exactly new, the literature pertaining to them is rather vague and indefinite. In fact there seems to be a decided lack of literature on the subject and in view of the great importance of these oils to the modern metal cutting industries and considering the large sums expended annually for them, the subject is undoubtedly worthy of the fullest investigation.

It is the writer's intention, in the present article, to give a general résumé of the composition, properties and industrial use of these compounded oils, coupled with concise directions for examining them, so that the chemist may thereby form an intelligent opinion of their worth. In this manner, by making a preliminary examination of such oils in the laboratory, the chemist can eliminate much worthless and unsuitable material and greatly assist a plant engineer or the purchasing department in deciding upon the oils best fitted for each particular purpose. Furthermore, all oils that are found to be especially effective for each specific purpose can be kept up to the same standard by frequent analysis; specifications can be devised and adhered to, and much time, annoyance and expense can be saved, instead of proceeding with time-consuming and frequently haphazard shop testing of oils purchased at random.

The usual physical tests, as applied to lubricating and other purely mineral oils, are not of much service in examining oils of this character, nor are the standard methods for determining the chemical constants of animal and vegetable oils and fats applicable, but rather a combination of both.

The literature pertaining to mineral oils and their derivatives and to other oils, fats and waxes is extensive, and, as it is not within the scope of this article to treat of these in detail, the reader is referred to standard works on the subject for more complete information.

As compounded oils, however, are composed of these two widely different classes of oils, a brief description of their general characteristics follows:

Commercial mineral oils are derived from the different fractional distillations of crude petroleum. They are simple hydrocarbon oils which do not contain any organic fatty acids and are therefore not affected by any of the ordinary saponification agents. They are not true definite compounds in a chemical sense, their composition depending entirely upon their source and the temperature at which each fraction is distilled.

Animal and vegetable oils, on the other hand, exhibit certain well defined chemical characteristics which are uniform, within certain limits, for each particular oil. Olive oil, for instance, has certain chemical constants which vary but little, no matter how widely separated are the sources from which it is derived, and this is especially true of pure oil, consequently its purity and composition can be definitely ascertained by chemical means.

These oils are rather complex substances formed from glycerol and organic fatty acids, technically known as triglycerides, and natural oils and fats are mixed triglycerides containing one or more different fatty acids. All triglycerides are broken up and decomposed by heating them with caustic alkalies, undergoing saponification or hydrolysis with the formation of the alkaline salts of the fatty acids, and glycerol. These alkaline salts are commonly known as soaps and it is due to this phenomenon that analysis and separations of mixed mineral, animal and vegetable oils can be made, by varying the menstruum in which they are soluble and by various other means.

In the following treatment of the subject an attempt has been made to present it mainly from a chemical viewpoint, the details of application being left to the more experienced shop engineers.

Numerous examples of analyses are given to assist the chemist in interpreting his results.

The writer begs indulgence for this verbose introduction and hopes to provoke a discussion of this highly important subject which has been very much neglected.

STRAIGHT CUTTING OILS

For the metal cutting and stamping industries, certain simple and compounded oils are required and the function of these so-called cutting oils is to furnish lubrication to the point or surface of the cutting tool and also to conduct away the large amount of heat generated, so that the tool will not become overheated and the temper drawn. Of course, with the modern high-speed tool steels, this heating of the tool itself has not the serious effects as on a plain carbon tool steel, but as cutting oils in general greatly improve the quality of the work, making smoother and speedier cuts and at the same time greatly prolonging the life of the tool; they are almost universally used in drilling, boring, reaming, milling and various other operations.

A great variety of oils and cutting compounds are manufactured and used for this purpose and they may be roughly subdivided into two general classes, *straight* cutting oils and *soluble* cutting oils.

The straight cutting oils are used directly on the machines without any further treatment and are intended mainly for the more delicate lathe work and fine boring and reaming operations and also for operations on high-carbon, special-alloy steels and other metals, in cases where the hardness or other physical properties of these metals require special treatment.

These oils consist of either lard oil, sperm oil, or vegetable oils or a mixture of one or more of these oils with certain mineral oils. Pure lard oil or a mixture of lard and mineral oil are the most extensively used members of this class. Pure mineral oil can also be used as a straight cutting oil but only to a limited extent.

Pure lard oil is pre-eminently the ideal straight cutting oil for all classes of work excepting that in which the amount of heat generated by the cut is high, thus making the cooling action of the lubricant very important. It seems to have the property of adhering tenaciously to the point or surface of the cutting tool even under the influence of moderate heat, a property that is not possessed by many other oils having a much higher viscosity. Under certain conditions and for special

purposes, where other simple and compounded oils fail, lard oil will generally prove effective.

Lard oil to be efficient, however, should be of the best quality, as the poorer grades contain considerable amounts of free fatty acids which tend to cause corrosion of brass, copper and other metals and to damage the bearings and other parts of the machines. An excessive amount of free fatty acid will also cause the oil to be foul smelling and will gum the machines.

The extensive use of lard oil as a cutting medium is limited, however, due mainly to its high cost, which is over one dollar per gallon at present* although it has been as low as 60 cents per gallon. This high cost has led to the introduction and substitution of mixtures of lard oil with petroleum oils and to the limited application of mineral and other inexpensive oils on certain classes of work where such substitutes would give satisfactory results.

These oils are now extensively manufactured and are known as mineralized lard oil, lardoleum and by various other trade names.

For straight cutting work, an oil must possess a moderately high viscosity, excellent heat conductivity, a high flash and fire test and a fairly low cold test. It should be free running, non-corrosive and must not thicken or gum in use. It should be compounded from good neutral mineral oils, possessing in general the qualifications of lard oil, and a good grade of lard oil containing a minimum of free fatty acid, not over 5 per cent at the most. The compounded oil should be a homogeneous mixture that must not segregate into its various components upon standing. Rancid oils should not be considered in an oil of this character, especially when masked by phenolic or other disinfectants, on account of the injurious effects it would have on the hands and persons of the workmen.

As a general rule the efficiency of these oils is governed by the amount of lard oil they contain, and the price is usually fixed by the same factor.

As lard oils and vegetable oils are saponifiable oils, and as mineral oils are non-saponifiable oils, it is evident that if a compounded oil be made from pure materials we have a ready means of evaluating them by simply determining the amount of saponifiable matter they contain. Also a determination of the acidity of the oil, coupled with the usual physical oil tests, would give a further indication of its value. Oils made from inferior materials can be separated by saponification processes and the inferior oils can then generally be positively identified.

Adulteration and substitution of the more expensive oils is sometimes practiced in the manufacture of cutting oils. For instance, lard oil is sometimes adulterated with cottonseed, rosin and various other oils. While cutting oils compounded from these various oils would be perfectly satisfactory for certain purposes, the purchaser does not wish to pay high prices for them expecting to get lard oil; consequently their detection becomes an important matter.

SOLUBLE CUTTING OILS

The soluble cutting oils are divided into many classes, but all depend upon the property of forming a milky emulsion when mixed with water. These oils are made and used primarily for heat conduction in heavy cutting, drilling, milling, stamping and other operations and at the same time they furnish considerable lubrication at the cutting points and surfaces. A saturated water solution of sal-soda was originally employed for this cooling purpose, but as it was devoid of lubricating properties, it has been largely replaced by soluble oil compounds.

These oils are usually compounded from mineral oils mixed with a specially treated animal or vegetable oil such as lard, cottonseed, corn, rapeseed, castor, olive rosin, neatsfoot and various other oils. They are known as sulphonated, phenolated and soap oils.

The *sulphonated oils* are made by treating castor oil with concentrated sulphuric acid, thereby forming a sulpho-compound with the ricinoleic acid of the oil. This treatment with sulphuric acid is proceeded with until a portion of the oil is found to be soluble in water. The mixture is then treated with common salt and the excess of acid is then neutralized with ammonia or other alkali. This base is then mixed with the proper proportion of mineral oil, sufficient care being taken to add enough of the base to hold all of the oil in an emulsion when the water is added. Turkey-red oil is an example of this class of oils and while castor oil is generally used, forming a true sulpho-compound, other oils such as cottonseed, olive, etc., may be substituted. These oils usually have an acid reaction toward phenolphthalein, and unless care is used in their manufacture they are liable to cause trouble by containing free sulphuric acid which would cause serious corrosion.

Soap oils (soluble oils containing soap) are compounded from mineral oils and a saponifiable oil, either animal or vegetable. Part or all of the animal or vegetable oil is saponified with an alkali, forming a soap, and the product is then added to the mineral oil in the proper proportions so that when it is diluted with water a creamy emulsion is formed, the soap acting as a carrier for the mineral oil and the unsaponified fat, holding these oils in suspension in the water. The free fatty acids, usually oleic or resin acids, are generally used for making the soap, being cheaper; this is then mixed with the neutral oil, the mineral oil and the other ingredients. Alcohol is sometimes added to effect a more ready solution of the soap and to keep the compounded oil clear. In this class of oils an excessive amount of soap should be avoided or gumming is liable to result. Amounts up to 15 per cent are permissible, but if they are properly manufactured less than 10 per cent seems to be quite sufficient.

The *phenolated oils* are similar to the soap oils in composition, being compounded from carbolic acid and an alkali. The phenolic odor of such oils suggests a disinfectant and is sometimes used to mask the odor of rancid fats. However, if these oils are properly made, this odor is not objectionable and is not detrimental.

Most of the soluble oils are of the above general classes and are manufactured under various trade names, the details of manufacture generally being kept secret by the makers. The subsequent analyses, made of various kinds of these soluble oils, will give an excellent idea of their general composition.

A first-class soluble oil should be a homogeneous mixture that should not segregate into its various components upon standing; it should form a perfect emulsion with water with the minimum separation of mineral oil. To give the best results soluble oils should be carefully

*When this was written (6-24-17) prime lard oil was $1.80 per gal.

made from high-grade materials, otherwise they are likely to cause trouble by rusting the machines and work, being corrosive and gumming the slides and other moving parts of the machines.

With soluble oils no hard and fast rules can be laid down for their evaluation. The total saponifiable matter, the percentage of free fatty acids, the neutral oil as fat and the amount of soap present are important considerations. Of decided importance is the stability of the emulsion formed with water at the various dilutions, as separation of the oil and water may cause damage to the tools, work or machines, besides losing the lubricating value of the compound. The amount of water and volatile matter present should also be considered, likewise any propensity toward gumming. The usual physical tests are not of much service in examining these oils, as they are never used in their original condition.

The intelligence and skill used in the manufacture of these oils is an important factor, as some oils containing a minimum amount of saponifiable matter, soap, etc., may be perfectly satisfactory, while conversely, an oil showing a relatively high percentage of these same constituents may be worthless, due to the lack of knowledge on the part of the manufacturer. As with straight cutting oils, no oil of this character should be considered that has been compounded from rancid and inferior animal or vegetable fats, the odor of which is usually masked by phenolic or other disinfectants.

Regarding the actual application of the various kinds of cutting oils and compounds, their use should be governed entirely by the conditions and the kind of work which they may be called upon to perform, and the treatment herein given, applying to this branch, has been more or less of a general nature.

For detailed information regarding the application, distribution, costs and other data concerning these oils, the reader is referred to a most complete and excellent article by Edward K. Hammond.[1]

Methods of Analysis

Two general methods were devised for the analysis of compounded oils, designated as A and B. Method A is a gravimetric separation of the saponifiable matter and the mineral oil and is useful as a check method and also where a further examination of the separated oils is contemplated, to determine their origin, nature and characteristics. Method B is a volumetric method and gives more complete information as to the condition of the saponifiable matter; it is also much more rapid. Both methods can be applied to the two classes of oils without any changes.

In the following methods, all flasks and other containers used for weighing samples and residues should be first thoroughly cleaned, rinsed with distilled water, alcohol, ether and then dried in an oven for one hour at a temperature of 100 deg. to 105 deg. C.

Preparation of Sample.—Mix the oil thoroughly by vigorously shaking the container, or, if in a barrel, by rolling it on the bilge; then fill two 4-ounce oil sample bottles with the well-mixed oil and label properly. Use one sample for the general analysis and place the other sample where it will not be disturbed for use later in the segregation test.

[1] *Machinery*, January, 1917.

Before commencing the analysis, the color, odor, turbidity and any other characteristics of the original oil should be noted.

Method A—Determination of Saponifiable Oil and Mineral Oil

Weigh 4 to 6 grams of the thoroughly mixed oil in a 300-cc Erlenmeyer flask, add 50 cc of the alcoholic potash (40 grams of potassium hydroxide dissolved in one liter of alcohol that has been redistilled after standing for some time over potassium hydroxide), and then boil the mixture under a reflux condenser for from one to two hours. An oil or water bath maintained at about 100° C., or an electric hot plate is suitable for boiling the liquid.

Disconnect the apparatus and boil off most of the alcohol, being careful not to overheat the oil or decomposition may result. Add about 50 cc of hot water to the residue in the flask, agitate and transfer to a 500-cc separatory funnel and wash out the contents of the flask with small successive portions of hot water, keeping the total volume in the funnel under 150 c.c. Cool the solution in running water and when cold add 75 cc of ether, stopper the funnel and shake vigorously. Allow the two layers to separate for about 12 hours or over night. If, after standing for some time, the solution does not show a tendency to separate into two distinct layers, the separation may be accelerated by adding a little alcohol, about 2 cc at a time, and shaking after each addition, which will usually effect a complete separation. The upper layer contains the ethereal solution of the unaffected mineral oil and the lower layer contains the animal or vegetable oil which has been converted into water soluble soap by saponification with the alcoholic potash.

Run the lower layer into another separatory funnel and wash the ethereal solution with about 50 cc of cold water, allowing the water to run down the sides of the funnel while rotating the same; allow to clear and then run the wash water into the second funnel. Add dilute sulphuric acid, containing about 5 cc of concentrated acid, to the soap solution in the second funnel to liberate the fatty acids. Cool in running water and when cold add 75 cc of ether, stopper the funnel and shake vigorously, allow to separate for about one-half hour or until clear and then run off the lower aqueous layer which is discarded.

Wash the ethereal solution of the fatty acids with about 50 cc. of cold water, allowing the water to run down the sides of the funnel while rotating the same; allow to clear, run off and repeat the washing with cold water until the wash water is no longer acid to blue litmus paper; about two washings will suffice.

Saponifiable Oil.—Drain off the wash water entirely from the ether solution of the fatty acids and then run the ethereal solution into a weighed 150-c.c. Erlenmeyer flask and rinse out the funnel with a small amount of ether. Cautiously evaporate off the ether and then heat the flask for one hour in a drying oven at a temperature of 100 to 105 deg. C., cool and weigh as saponifiable matter. The saponifiable matter in this case consists of the hydrates of the fatty acids. If any water is carried over into the ether solution, it may be removed when heating the residue, by spreading the oil in a thin layer over the interior of the flask; any water

present is then more easily volatilized without causing the oil to spurt.

Mineral Oil.—Drain off the wash water entirely from the ethereal solution of the mineral oil in the first funnel and then run the ethereal solution into a weighed 150-c.c. Erlenmeyer flask and rinse out the funnel with a small amount of ether. Proceed with the evaporation, heating, etc., exactly as directed for the determination of the saponifiable oil, finally weighing the product as mineral oil.

Method B—Determination of Total Saponifiable Matter and Total Fatty Acids

Weigh 4 to 6 grams of the oil in a 300-c.c. Erlenmeyer flask, add 50 c.c. of the alcoholic potash solution and boil the mixture under a reflux condenser for from one to two hours. Disconnect the apparatus, boil off most of the alcohol, add about 50 c.c. of hot water to the residue, agitate and transfer to a 500-c.c. separatory funnel and wash out the flask with small successive portions of hot water. Add dilute sulphuric acid, containing about 5 c.c. of concentrated acid, to the solution in the funnel and cool in running water; when cold add 75 c.c. of ether, stopper and shake vigorously. Allow the two layers to separate for about one-half hour or longer if necessary; when clear, run off the lower aqueous layer and discard. Wash the ethereal solution with about 50 c.c. of cold water, allowing the water to run down the sides of the funnel while rotating the same, being careful not to disturb the ethereal layer too much, as troublesome emulsions are liable to be formed. Allow to stand until clear, run off the wash water, discard and repeat the washing with cold water until the wash water is free from acid when tested with blue litmus paper, about two washings will suffice. Drain the ethereal solution into the original flask, which has been rinsed with a little alcohol and allowed to drain, and wash out the funnel with a small amount of ether. Cautiously evaporate the solution in the flask until most of the ether has been driven off.

Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of a 1 per cent solution of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking. The flask should be stoppered and shaken vigorously toward the end of the titration.

Total Saponifiable Matter.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.028773 and divide by the weight of the sample taken, to obtain the total saponifiable matter in one gram of the oil.

In this titration it is assumed that one gram of the saponifiable matter requires 195 milligrams of potassium hydroxide for its saturation, i.e. it has a saponification value of 195. One cubic centimeter of tenth-normal alkali is equivalent to 0.0056108 grams of potassium hydroxide, consequently

$$\frac{0.0056108}{0.195} = 0.028773.$$

This factor is accurate for most of the oils entering into this class of compounds; exceptions will be noted later.

Total Fatty Acids.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken, to obtain the total fatty acids in one gram of the oil.

The above factor is based on the assumption that the fatty acids exist as oleic or some similar acid, which is a very close approximation of the truth; exceptions will be noted later.

DETERMINATION OF FREE FATTY ACIDS

Weigh 5 to 10 grams of the oil in a 300-c.c. Erlenmeyer flask. Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking. The flask should be stoppered and vigorously shaken toward the end of the titration.

Free Fatty Acids.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken, to obtain the free fatty acids, as oleic acid, in one gram of the oil.

DETERMINATION OF SOAP, FATTY ACIDS COMBINED AS SOAP, FATTY ACIDS COMBINED AS FAT AND NEUTRAL OIL

Weigh 4 to 6 grams of the oil in a 300-c.c. Erlenmeyer flask, add about 50 c.c. of hot water, agitate, transfer to a 500-c.c. separatory funnel and wash out the flask with small successive portions of hot water. Add dilute sulphuric acid, containing about 5 c.c. of concentrated acid, to the solution in the funnel and cool in running water. When cold, add 75 c.c. of ether, stopper the funnel and shake vigorously. Allow the two layers to separate for about one-half hour or longer if necessary; when clear, run off the lower aqueous layer and discard. Wash the ethereal layer with about 50 c.c. of cold water, allowing the water to run down the sides of the funnel while rotating the same. Allow to stand until clear, run off the wash water and repeat the washing with cold water until the wash water is no longer acid when tested with blue litmus paper; about two washings will suffice. Run the ethereal solution into the original flask, which has been previously rinsed with a little alcohol and allowed to drain and carefully evaporate off most of the ether.

Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking of the stoppered flask.

Fatty Acids as Soap.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken and call the result (*a*). Subtract from this result the free fatty acids, per gram of oil, as found in a previous determination, and the remainder is the fatty acids combined as soap in one gram of the oil.

Soap.—Multiply the result obtained for the fatty acids combined as soap by 1.078; the product is the sodium soap formed by the alkali and these acids.

Sodium soap (sodium oleate), mol. weight.

$$\frac{304}{282} = 1.078.$$

Fatty acids (oleic acid), mol. weight

$$\frac{304}{282} = 1.078.$$

If a potassium soap is required, substitute the factor 1.13 in the above calculation.

Fatty Acids as Fat.—Subtract the result (*a*) from the total fatty acids found in a previous determination, to obtain the fatty acids combined as fat in 1 gram of the oil.

Neutral Fatty Oil.—Subtract the result (*a*) from the total saponifiable matter found in a previous determination, to obtain the neutral fatty oil in 1 gram of the sample.

NOTES

All of the determinations in the foregoing methods of analysis are applicable and useful in the examination of soluble cutting oils, but as straight cutting oils obviously do not contain soap nor fatty acids as soap, these determinations are omitted. There are actually only three determinations in method B, the other information being obtained by simple calculations. Much time can be saved if the titrations are all performed at one time and several oils can be analyzed successively, leaving the titrations to the last. The end point in these titrations is usually very sharp, but if any trouble is experienced in accurately determining this point with dark-colored oils, by titrating back with tenth-normal hydrochloric acid, the change can be rendered very distinct so that one or two drops of either standard solution will give the color reaction. It is advisable to follow this procedure in all of the titrations, as very concordant results can then be obtained and over-titrations avoided.

As method A gravimetrically determines only the hydrates of the fatty acids that exist in the oil, the results by this method will be a trifle low for oils where these fatty acids were originally present as neutral fatty oil, due to the loss of the glycerol radicle. This loss is somewhat compensated for, due to the fact that the fatty acids are weighed as hydrates and not as anhydrides.

In method B the total saponifiable matter is based on the assumption that the oil has a saponification value of 195, which is correct for most of the oils entering into this class of compounds. Sulphonated oils, however, usually contain a castor oil base which has a saponification value of about 184, consequently

$$\frac{0.0056108}{0.184} = 0.0305.$$

This factor would be the proper one to use when castor oil is required and 0.02983 would be the correct factor for the ricinoleic acid of this oil.

PHYSICAL TESTS

Emulsification Test.—Prepare an emulsion of the soluble oil by mixing a measured portion of the oil with the required amount of water, place in a 4-ounce oil sample bottle and set aside for further observation. One part of oil to ten or twenty parts of water is sufficient for test purposes, but any other required volume of water may be used. The character of the emulsion should be noted while preparing the same and again examined after standing undisturbed for 24 hours.

Segregation Test.—After standing for at least 24 hours, weigh out a portion of the oil which was placed aside for the segregation test, by pouring from the upper surface without disturbing the rest of the oil. Make a determination of the free fatty acids or the total saponifiable matter on this sample. Any difference in this determination from the one made with the well-mixed sample is proof of the segregation of the oil into its various components; this segregation increasing, of course, the longer the oil is allowed to stand undisturbed until it reaches a maximum.

Evaporation Test.—Weigh 1 to 2 grams of the oil in a weighed Petri dish or in a shallow flat aluminium dish about 50 to 75 mm. in diameter. Place in a drying oven and heat at a temperature of 100 to 105 deg. C. for about 3 hours, cool and weigh. Replace in the oven for 30 minutes, cool, weigh and repeat the operation until a fairly constant weight is obtained. The loss in weight divided by the weight of the sample taken is the water, alcohol and any other volatile matter in 1 gram of the oil. The residue should then be examined to see if it shows any tendency toward gumming.

Compounded oils that contain light mineral oils will require heating over long periods, as considerable portions of this light oil will volatilize at this temperature.

To determine the amount of volatile mineral oil, first ascertain the temperature at which the oil will flash when it is heated in an open cup tester and then proceed as follows: Weigh out a portion of the mineral oil, which has been separated by method A, into the evaporating dish, as directed above. There seems to be very little loss of mineral oil when it is dried in the flask as directed in method A, which is probably due to the shape of the flask.

Place the dish containing the oil in the drying oven and heat at a few degrees below the flashing temperature until the weight is fairly constant. The loss in weight divided by the weight of the oil taken will give the amount of mineral oil volatile at this temperature, and this result divided by the percentage of total mineral oil will give the percentage of volatile mineral oil.

Physical Oil Tests.—The usual physical oil tests are too well known to require more than a brief mention here.

Determine the specific gravity with a Westphal balance or with an accurately calibrated hydrometer. The hydrometer is usually used and is much more rapid.

Determine the flash and fire test in an open cup tester of the Cleveland type.

The viscosity should be determined at 100 deg. Fahr. with a Saybolt viscosimeter. If the oil is too viscous to determine its viscosity at this temperature, a higher temperature may be employed. Most cutting oils, however, will move freely at 100 deg. Fahr., and as the results are only comparative this or some other uniform temperature should always be employed.

For the cold and cloud tests, any standard or suitably assembled apparatus may be used, the temperature being varied, of course, to suit the requirements of the oil being tested.

The above tests apply mainly to straight cutting oils.

Analyses of Soluble Cutting Oils

Following is an analysis of a soluble cutting oil and the results shown demonstrate the agreement and uni-

Oil No. 1

Test No.	Total saponifiable matter	Total fatty acids	Free fatty acids	Fatty acids as fat	Fatty acids as soap	Soap	Neutral fatty oil	Mineral oil
Method A—								
1	18.96	...	...	...	...	...	...	72.14
2	18.83	...	...	...	...	...	...	72.02
3	18.67	...	...	...	...	...	...	72.20
Average	18.82	...	...	...	...	...	...	72.12
Method B—								
1	18.81	18.44	6.25	0.98	11.21	12.12	1.35	...
2	18.71	18.34	6.21	0.98	11.15	12.05	1.35	...
3	18.65	18.28	6.13	0.98	11.17	12.07	1.35	...
Average	18.72	18.35	6.20	0.98	11.18	12.08	1.35	...

Water and volatile matter, 8.26 per cent.

formity that may ordinarily be expected in an analysis by the foregoing methods.

In its original condition this oil is a cloudy, reddish, viscous liquid, possessing a slight alcoholic odor and undergoing oxidation if left exposed to the air, a thick scum being formed on the surface. This oil is evidently a soap oil, as shown by the moderately large amount of soap present, and furthermore, that this oil was compounded from fatty acids is shown by the large amount of free fatty acid and the small amount of neutral fatty oil found; of the 18.72 per cent of total saponifiable matter, 17.38 per cent was present in the original oil as fatty acid and 1.35 per cent as neutral fatty oil. The fatty acid used was evidently oleic acid.

After standing for different periods the original oil showed a decided tendency to segregate, the total saponifiable matter varying from 6 to 20 per cent, the soap evidently precipitating and settling to the bottom of the container.

The 1 to 10 and 1 to 20 water emulsion, prepared with either warm or cold water and the well-mixed oil, is fair, emulsion is cream colored, foaming slightly when agitated; after 24 hours had a slight curd on the surface and a slight separation of mineral oil. The emulsion prepared from the oil after standing, without mixing thoroughly, is very poor, a large proportion of the mineral oil separating immediately.

This oil could not be recommended except in cases where a low price might prove a consideration, as its segregating and oxidizing properties would require special care and precaution in mixing. The price of this oil is about 50 cents per gallon, consequently the above objections would practically eliminate it, as much better oils can be obtained for the same price.

The general composition of this oil would be about as follows:

Mineral oil	72.12%
Free fatty acid	6.20%
Soap	12.08%
Neutral fatty oil	1.35%
Water and volatile matter	8.26%
Total	100.01%

Oil No. 2

	Method A	Method B	Castor Oil Base
Total saponifiable matter	12.86%	12.12%	12.92%
Total fatty acids		11.86%	12.56%
Free fatty acids		11.43%	12.08%
Fatty acids as fat		0.17%	0.21%
Fatty acids as soap		0.25%	....
Soap		0.28%	....
Neutral fatty oil		0.44%	0.62%
Mineral oil	77.57%	....	....
Total volatile matter			25.35%
Volatile mineral oil			18.30%
Water, ammonia, alcohol, etc			7.05%

The above is an analysis of a soluble oil which was clear, wine-red and rather fluid in its original condition and possessed a strong odor of ammonia and kerosene or some similar volatile mineral oil. The presence of ammonia was shown by the vapor from the oil causing red litmus paper to turn blue. The original oil flashed at 150 deg. Fahr. and burned at 160 deg. Fahr. in an open cup tester, showing conclusively the presence of light mineral oils, kerosene or gasoline, which were present to the extent of 18.30 per cent, as shown by an evaporation test.

The reaction of the oil toward phenolphthalein was acid, notwithstanding the ammonia which was present which does not affect this indicator; this acid reaction was due to the organic acids present.

That this oil is evidently a sulphonated oil is shown by the absence of soap and by the large amount of free fatty acids present; the saponifiable matter in such an oil would be largely in the form of sulpho-acids.

This oil was analyzed by methods A and B; method A determines the total fatty acids gravimetrically; method B is evidently too low based on the assumption that the saponifiable matter is lard oil or some similar oil with a saponification value of 195. Sulphonated oils are usually made from castor oil which has a saponification value of about 184, consequently basing our calculations on this value and figuring the fatty acids as ricinoleic acid, we get the results as tabulated under castor oil base; the results for the total saponifiable matter by both methods then agree closely.

This oil showed but very slight tendency to segregate in its original condition and it does not oxidize or thicken on exposure to the air. The slight segregation consists in forcing more of the sulpho-base to the surface of the oil.

The 1 to 10 and 1 to 20 emulsions formed with cool water were excellent, foaming slightly in preparation; after standing for 24 hours showed a slight curd on the surface and a slight separation of mineral oil. Hot water should not be used, as it causes a decided separation of mineral oil.

The above oil can be recommended for excellent emulsification, freedom from oxidation, thickening, gumming; for non-segregation and freedom from mineral acids and other corrosive agents. The main objection is the presence of considerable volatile mineral oil, which would constitute a fire hazard if the oil be left exposed before using; this objection, however, does not apply to any great extent after the oil has been emulsified. The price is 48 cents per gallon.

The general composition of this oil would be about as follows:

Non-volatile mineral oil	59.27%
Volatile mineral oil	18.30%
Fatty sulpho-acids	15.34%
Neutral fatty oil	0.62%
Water, ammonia and other volatiles	7.05%
Total	100.58%

Oil No. 3

	Method A	Method B
Total saponifiable matter	15.30%	15.57%
Total fatty acids		15.25%
Free fatty acids		0.13%
Fatty acids as fat		5.47%
Fatty acids as soap		9.65%
Soap		10.40%
Neutral fatty oil		5.80%
Mineral oil	75.50%	....
Total saponifiable matter after standing (segregation)		8.58%
Total saponifiable matter of the well mixed oil (segregation)		15.57%
Water, alcohol, etc		8.40%

The above is an analysis of a soluble oil which was a

clear, brown-red fluid oil in its original condition with a slight alcoholic phenol odor.

That this oil is evidently a soap oil is shown by the presence of considerable soap and that it was compounded from good neutral oils is shown by the trifling amount of free fatty acids present.

In its original condition this oil showed a decided tendency to segregate upon standing and this segregation consisted in the settling out of the soap, forcing the volatile matter and mineral oil to the surface.

The 1 to 10 and 1 to 20 emulsions formed with cool water were very poor, the mineral oil separating almost immediately; after standing for 24 hours there was a large separation of mineral oil. The same result was obtained by using warm water for the emulsion.

The above oil could not be recommended because of its segregation and for its poor emulsification qualities. The price is 48 cents per gallon.

This oil is an example of good materials being compounded into a poor soluble oil by lack of skill and knowledge on the part of the manufacturer; the defect in this case being possibly an insufficiency of soap to carry all of the particular mineral oil in suspension when it is diluted with water.

The general composition of this oil would be about as follows:

Mineral oil	75.50%
Neutral fatty oil	5.80%
Soap	10.40%
Free fatty acids	0.13%
Water, alcohol, etc.	8.40%
Total	100.23%

Oil No. 4

	Method A	Method B
Total saponifiable matter	17.06%	16.37%
Total fatty acids		16.05%
Free fatty acids		4.68%
Fatty acids as fat		3.71%
Fatty acids as soap		7.66%
Soap		8.26%
Neutral fatty oil		4.03%
Mineral oil	76.26%	

Water, alcohol, etc., 7.00%. Segregation, none.

The above is an analysis of a soluble oil which, in its original condition, is a clear, dark-red, fluid oil possessing a slight odor of alcohol and a deep blue bloom or fluorescence.

This oil is a soap oil which does not oxidize or thicken on exposure to the air; an evaporation test showed no gummy residue, and the oil does not segregate upon standing.

The 1 to 10 and 1 to 20 emulsions formed with warm or cold water were excellent white emulsions, foaming slightly in preparation; after 24 hours there was no separation of mineral oil and no formation of curd.

This oil could be highly recommended for its non-segregation, freedom from thickening, oxidizing, gumming and for perfect emulsifying qualities. The price is 45 cents per gallon.

This oil is an example of what would constitute a nearly perfect oil which has been compounded properly and at the same time containing only a moderate amount of soap and saponifiable matter.

The general composition of this oil would be represented by the following:

Mineral oil	76.26%
Neutral fatty oil	4.03%
Free fatty acids	4.68%
Soap	8.26%
Water, alcohol, etc.	7.00%
Total	100.23%

Oil No. 5

	Method A	Method B	Castor Oil Base
Total saponifiable matter	18.24%	17.21%	18.29%
Total fatty acids		16.86%	17.82%
Free fatty acids		14.80%	15.65%
Fatty acids as fat		1.62%	1.70%
Neutral fatty oil		1.97%	2.17%
Mineral oil	75.22%		
Total volatile matter			17.37%
Volatile mineral oil (segregation very slight)			14.07%
Water, ammonia, etc.			3.30%

The above is an analysis of a soluble oil which, in its original condition, was a clear, wine-red, fluid oil possessing a strong odor of ammonia and a deep fluorescence or bloom. This oil contained considerable quantities of volatile mineral oils, the original oil flashing at 135 deg. Fahr. and burning at 145 deg. Fahr.

An inspection of the analysis shows this oil is a sulphonated oil and it possesses in general the characteristics of Oil No. 2 regarding segregation, emulsification, oxidation, thickening, gumming and freedom from corrosive acids.

It can be recommended, with reservations as to fire hazard, the same as the preceding oil. The price is 44 cents per gallon.

The general composition of this oil would be about as follows:

Non-volatile mineral oil	61.15%
Volatile mineral oil	14.07%
Fatty sulpho-acids	19.87%
Neutral fatty oil	2.17%
Water, ammonia, etc.	3.30%
Total	100.56%

Oil No. 6

	Method A	Method B
Total saponifiable matter	22.00%	21.71%
Total fatty acids		21.30%
Free fatty acids		5.08%
Fatty acids as fat		8.90%
Fatty acids as soap		7.32%
Soap		7.88%
Neutral fatty oil		9.31%
Mineral oil	67.25%	

Water, alcohol etc., 10.68%.
Free fatty acids after standing 24 hours, 4.28%
= 8.42% segregation.
Free fatty acids of well mixed oil, 5.08%

The above is an analysis of a soluble oil which, in its original condition, is a clear, red, fluid oil possessing an alcoholic odor and a slight bloom.

The main defect in this oil is its segregation, which consists in the precipitation of soap and fatty matter, this material settling slowly to the bottom of the container.

Emulsion is good, very slight separation of curd and mineral oil.

This oil could be recommended as a good oil except for its segregation. The price is 45 cents per gallon. Its general composition follows:

Mineral oil	67.25%
Neutral fatty oil	9.31%
Free fatty acids	5.08%
Soap	7.88%
Water, alcohol, etc.	10.68%
Total	100.20%

Oil No. 7

	Method A	Method B
Total saponifiable matter	12.70%	12.80%
Total fatty acids		12.54%
Free fatty acids		4.23%
Fatty acids as fat		0.57%
Fatty acids as soap		7.74%
Soap		8.34%
Neutral fatty oil		0.83%
Mineral oil	79.08%	

Water, alcohol, etc., 7.60%. Segregation, none.

The above is an analysis of a soluble oil which is a

clear, dark-red, fluid oil possessing an alcoholic odor and a deep blue bloom.

This oil is almost identical with Oil No. 4, excepting that it contains less saponifiable matter; it is made by a different manufacturer.

This oil can be recommended in every respect as a high-class oil. The price is 50 cents per gallon.

The general composition of this oil is about as follows:

Mineral oil	79.08%
Neutral fatty oil	0.83%
Free fatty acids	4.23%
Soap	8.36%
Water, alcohol, etc.	7.60%
Total	100.10%

Oil No. 8

Total saponifiable oil	24.87%
Mineral oil	74.72%
Total	99.59%
Free fatty acids	12.76%
Specific gravity at 60 deg. F.	0.892
Baumé at 60 deg. F.	26.9 deg.
Flash test	355.0 deg. F.
Fire test	390.0 deg. F.
Viscosity at 100 deg. F.	111.0 sec.

The above is an analysis of a straight cutting oil, a turbid, odorless, dark colored oil which contained precipitated fats, probably stearine or stearic acid, this precipitate settling to the bottom of the container upon standing.

This oil should be rejected for excessive free fatty acids and for low viscosity. The price is 45 cents per gallon.

Oil No. 9

Total saponifiable oil	32.20%
Mineral oil	67.60%
Total	99.80%
Free fatty acids	4.15%
Specific gravity at 60 deg. F.	0.889
Baumé at 60 deg. F.	27.5 deg.
Flash test	396.0 deg. F.
Fire test	440.0 deg. F.
Viscosity at 100 deg. F.	192.0 sec.

The above is an analysis of a straight cutting oil, a clear, dark-red oil, possessing a slight blue bloom and a lard oil odor. There is no segregation in this oil and the separated saponifiable oil is light-colored and free from objectionable odor.

This oil can be recommended for moderately low free fatty acid content, adequate viscosity, flash and fire test and for good general composition. It can be safely used on all such cutting work for which it would prove satisfactory.

The price is 60 cents per gallon.

Oil No. 10

Total saponifiable oil	11.60%
Mineral oil	88.00%
Total	99.60%
Free fatty acids	3.10%
Specific gravity at 60 deg. F.	0.900
Baumé at 60 deg. F.	25.4 deg.
Flash test	360.0 deg. F.
Fire test	410.0 deg. F.
Viscosity at 100 deg. F.	164.0 sec.

The above is an analysis of a straight cutting oil, a black-colored, opaque oil with a very disagreeable odor. Saponifiable oil has a rotten odor, suggesting Dippel animal oils.

This oil should be rejected for poor composition, being compounded from inferior animal oils.

Oil No. 11

Total saponifiable matter	18.88%
Mineral oil	81.00%
Total	99.88%
Free fatty acids	2.08%
Specific gravity at 60 deg. F.	0.883
Baumé at 60 deg. F.	28.5 deg.
Flash test	410.0 deg. F.
Fire test	455.0 deg. F.
Viscosity at 100 deg. F.	176.0 sec.

The above is an analysis of a straight cutting oil, a clear, reddish oil, possessing a slight blue bloom and a slight lard oil odor. Saponifiable oil is light colored, with an odor of lard oil. There is no segregation in this oil.

This oil can be recommended for purity of composition, low free fatty acid content, adequate viscosity, high flash and fire test and moderate price.

It can be safely used for all such cutting work, for which it will prove satisfactory. The price is 37 cents per gallon.

Remington Arms Company of Delaware.
Eddystone, Pa.

Industrial Wastes Disposal*

By Harrison P. Eddy

Of Metcalf & Eddy, Consulting Engineers, Boston and Chicago.

While there are various waste materials resulting from the industries, the term "industrial wastes" has come to mean the liquid wastes from the processes employed in industrial establishments. In England they are called "trade wastes"—a term not quite as applicable in this country, although occasionally used. Neither the human excrement of operatives nor their wash waters are comprehended in this term, although in many cases there is no effort to prevent their admixture.

ORIGIN OF INDUSTRIAL WASTES.

Many industries employ great quantities of water for various purposes such as condensing, washing of raw stock, dilution of chemicals, transportation and application of materials and the washing and rinsing of finished products.

Some of these uses do not defile the water and it can be discharged at will, as for example many condenser waters. Other uses result in a very great change in the character of the water and render it unsuitable for discharge into some waterways.

In paper mills, after the digestion of the raw stock with strong chemicals, there remain the liquors, highly charged with mineral and organic substances, but for which the manufacturer has no further use. He therefore seeks to get rid of them in the most expeditious and least expensive manner. The fibrous stock is then washed and large quantities of wastes are discharged from the washers, more or less highly charged with substances like those already mentioned. From the paper machines come great quantities of water carrying fine fiber, clay, coloring matter and other substances depending upon the character of paper made and the processes employed.

In tanneries, pure water is indispensable, but after use it is highly colored, charged with spent chemicals and loaded with organic matter. Its burden of im-

*A paper read at the Buffalo meeting of the American Institute of Chemical Engineers, June 20, 1917.

purity is partly in suspension and partly in solution. Wastes from different processes within the same tannery often react upon one another, throwing out of solution substances which in their new physical condition may be deposited in waterways to their detriment. Some tannery wastes of themselves are so resistant to bacterial action that they do not readily putrefy, yet when diluted with the waters of a natural stream they may become most offensive.

The wastes of woolen mills vary radically from those of paper mills and tanneries, yet they may be the cause of just as serious complaints. The grease and soaps from the scouring of the wool, the spent dye liquors, the soaps from the cloth-washing and the rinse waters in the aggregate, are of great quantity, highly colored, turbid, charged with suspended matter and quite capable of transforming an attractive stream into an unsightly, foul-smelling and quite unattractive waterway.

Instances like the foregoing might be multiplied almost without end. Some of the other industries which have encountered difficulties in the disposal of wastes are wire-drawing and galvanizing works, carpet mills, dyeing and bleaching works, strawboard factories, slaughtering and packing houses, breweries, distilleries, gas works, chemical and explosive works, and mines and coal washing plants.

EFFECTS OF WASTES UPON WATERWAYS

The ingredients of industrial wastes may be grouped in three main classes: first, floating and suspended matter; second, substances in solution, in colloidal condition and in an extremely fine state of suspension, and third, bacteria.

Floating and suspended substances may render the waters into which they are discharged, unsightly, and cause deposits. Such deposits, if of organic matter, often deprive the overlying water of a large proportion of its natural content of dissolved oxygen which is necessary for the maintenance of biological equilibrium and the prevention of putrefaction. Decomposition is accompanied by the generation of large quantities of gas, some of which is entrained in the mud until it has accumulated sufficiently to enable it to buoy up large masses which may be seen floating for a time upon the surface of the water only to be broken up and redeposited upon the liberation of the gases.

Dissolved substances almost always accompany the suspended matter in industrial wastes. Sometimes they are much more troublesome. They, too, cause the depletion of the oxygen supply, usually through the action of the bacteria of decomposition. Particularly objectionable and difficult to treat are those wastes containing large quantities of very finely divided suspended matter and colloidal substances. Usually impurities of this class pass along with the waters of the stream into which they are discharged and do not form deposits. However, under some circumstances such ingredients are coagulated and thrown down, sometimes by the reaction of wastes of one process with those of another, and at others by natural physical, chemical and biological processes going on in the waters.

Most industrial wastes contain bacteria. These may not be pathogenic germs. In fact, they may be decidedly helpful in the problem of disposal, rather than harmful. There are abundant opportunities in some of the industries, however, for the pathogenic organisms to escape in the liquid wastes and thus contaminate the waters into which such wastes are discharged. One of the most dreaded organisms which may be spread about in this manner is the anthrax bacillus, sometimes present in hides, skins and wool. This organism is very hardy and appears to maintain its virility through its spores for many years.

Excrementitious matter from operatives is often combined with the industrial wastes and thus the entire flow may be rendered bacterially dangerous.

Wastes may cause objectionable conditions in many ways depending upon their character and the size and condition of the waterway into which they are discharged. They may contaminate a water supply, render a stream unsightly and objectionable in appearance, cause putrefying deposits, render the natural waters putrid and offensive, poison or otherwise kill fish, and injure vegetation. Strange and contradictory as it may sound, complaint is frequently made that wastes are killing vegetation and about equally often that they are so encouraging the growth of vegetation as to do serious damage. If one complaint doesn't apply the other usually does.

It might appear that as the industries are the offenders in this field of activity, there would be few complaints from them of the conditions produced by the discharge of industrial wastes. Just the contrary is true. One of the most common complaints comes from the manufacturer to the effect that an upper riparian industry is rendering the water unfit for use in his plant.

SELECTION OF FACTORY SITES.

Enough has been stated to show how wide-spread is the trouble in disposing of industrial wastes. When about to establish a new industry or plant, the proprietors usually make thorough investigation of the quality of the water available for their use. The extent of the supply is also generally investigated and often such collateral questions as the amount of power derivable from the passing stream. But how infrequently do they make even a superficial study of the problem of wastes disposal. Yet this may be a greater and more difficult problem than that of water supply.

Expenditures of $100,000 or $200,000 for wastes treatment plants and of $25,000 to $40,000 annually for the operation of such plants are becoming more and more frequent. Capitalizing the annual expenditure of $25,000 at 5 per cent and adding $100,000 for construction cost, making no allowance for depreciation, it appears that the industry might have expended as much as $600,000 in procuring a site which would not have entailed the necessity of wastes treatment.

The selection of a suitable site for an industry producing large quantities of wastes is a matter of much importance. Even though conditions at the outset appear to be favorable they may be materially altered by establishment of new industries down-stream or by an increase of riparian population below the plant.

TREATMENT OF WASTES

When it is impracticable to afford the wastes sufficient dilution to prevent the production of unsatisfactory conditions, it becomes necessary so to modify the character of the wastes that they will not cause complaint.

One often hears that wastes cannot be so treated; that if a way were known the manufacturer would gladly adopt it. This impression that the wastes cannot be successfully treated is in many cases not true, and it may be accepted that they can be so treated as to remove their objectionable and deleterious properties before their discharge into natural waterways.

On the other hand, such treatment may be and often is a very expensive undertaking and one from which the manufacturer naturally shrinks on this account and also because he personally is not familiar with the process necessary to the accomplishment of the object.

Perhaps the most important step in the solution of this problem is the determination of the extent of treatment necessary to meet the requirements of the case. To answer this question intelligently it is necessary to know the character and quantity of the wastes produced, the character of and conditions surrounding the waterway into which they are being discharged, and their effect upon the waters in question.

The next step is to determine how best to treat the wastes to accomplish the necessary results at a minimum cost and, in any event, one which is not prohibitive. There have been instances when the plant proposed for such treatment would have cost a sum about equal to the value of the entire industrial plant of which it was to become a minor part. Such a suggestion is absurd and tends to reduce or extinguish the respect of the manufacturer for the party making the suggestion, for the officials trying to enforce the laws, and even for the laws themselves.

For the removal of the suspended matter screening may suffice under some conditions, while others may require the more complete removal by sedimentation. When the substances in suspension are of very light specific gravity and finely divided, it may be necessary to resort to chemical precipitation.

Some dissolved matters may be removed by chemical precipitation, while others can be modified in character by chemical treatment without actual removal. If they are organic and subject to putrefaction, bacterial action may be required for their oxidation, as in sewage treatment.

Certain wastes are bacterially dangerous and it may be necessary to destroy the pathogens even where the suspended and dissolved matters would cause no harm. In such cases the treatment of the wastes may be all that is essential, while in others it may be necessary even to treat the raw material as has been suggested in the case of anthrax-infected hides.

It should not be inferred from this discussion that a single process can be selected for each case, for it often requires several to accomplish the desired result.

At one plant where the author's firm has supervisory charge of the wastes disposal department, no less than seven steps have been employed at one time. These are degreasing of a portion of the wastes, sedimentation of the wastes, chemical treatment of the settled effluent, filtration of a portion and dilution of the remainder of the chemical effluent and finally the introduction of chemicals to prevent the exhaustion of the supply of oxygen in the river.

VARIATION OF TREATMENT FROM TIME TO TIME

The process adopted should in many cases be varied from time to time to take advantage of favorable or to offset unfavorable conditions. The volume of business being done may materially affect the quantity of wastes produced and correspondingly make the condition dictating treatment more or less exacting. Industrial processes frequently are changed requiring modification in the treatment methods.

In winter temperatures may be sufficiently low to retard or even prevent putrefaction under conditions which in summer would transform a natural waterway into a stinking slough.

In spring there are usually large volumes of diluting water which may make bacterial oxidation in filters unnecessary, at a time when the filters would be working under most unfavorable conditions.

All of these and innumerable other conditions must be taken into consideration if success is to be attained at a minimum cost.

ADVISABILITY OF ANTICIPATING COMPLAINT

In many cases industrial establishments which are now of great size have grown from very modest beginnings, often from merely a room or two adjacent to a water privilege which was the primary reason for the selection of the site. As the business has grown through the decades conditions have entirely changed. What was an abundant supply of water not only for industrial purposes but also for the dilution of the wastes, has now become barely adequate for industrial purposes alone and the entire flow now passes through the plant and perhaps through several plants more recently built. Thus the entire stream has become a river of industrial wastes rather than, as originally, a natural river into which a minor quantity of industrial wastes was discharged.

In all such cases there has been a collateral increase in the resident population. Now there are villages along the river where formerly were wooded lands and pastures. Such development has brought with it demands for parks and other recreation facilities, including the improvement of the natural stream for boating and perhaps for bathing purposes.

Under some conditions a proscriptive right may be acquired to make certain uses of the waters of the river, even though they be more or less hostile to the enjoyment of some privileges by lower riparian owners. The proscriptive right is often advanced in defense of the practice of discharging untreated industrial wastes into waterways and their consequent pollution. Many of the industries, particularly in the eastern part of the country, are of very long standing. The continuous operation of an industrial plant devoted to the same general kind of work for more than a century can be cited in numerous instances. In comparatively few cases, however, can it be shown that such industries are operating under conditions substantially identical with those of prior decades. Either the character of the business has changed so that processes are different and industrial wastes are greater or less in quantity and decidedly altered in character, or the business as a whole has become much greater with a corresponding increase in the quantity of industrial wastes. These changes make it exceedingly difficult in most cases to establish a proscriptive right to the acts of which complaint is made.

It should be borne in mind that in no case can one acquire a right, by proscription or otherwise, to create a nuisance. This fact has been the stumbling block upon

which many an effort to secure or maintain privileges, through court decisions, has been defeated.

The paramount lesson to be gained from experience in these matters is that it is wise to anticipate complaint of objectionable conditions whether from lower riparian manufacturers influenced by difficulties caused by the character of the water, from a community complaining because of odors and objectionable appearance of the stream, or from the farmer whose cattle will not drink the water, whose crops are killed because of inundation by polluted waters, or whose ditches and natural brooks have become so overgrown with vegetation due to the fertilizing ingredients of the waters having their origin in industrial wastes, that they will no longer serve their purpose.

The prudent manufacturer will make it a part of his routine business carefully to observe the effect of the discharges from his plant, upon the character of the water in the river, not alone in his immediate vicinity, but for a considerable distance down-stream. When conditions become noticeably objectionable he will take measures to remedy them, at the same time maintaining the valuable privilege of utilizing the stream for the disposal of his wastes to as great an extent as is compatible with the public good and the reasonable use of the waters by lower riparian manufacturers. Such a policy, if intelligently pursued, will result in many cases in avoiding expensive litigation. More important than this, however, is the fact that by maintaining the waterway in a reasonably satisfactory condition the hostility of lower riparian dwellers may be avoided. Where such a feeling is aroused by objectionable conditions, it may exert itself through legislation or through litigation in such a manner as to require the establishment of exceedingly rigid restrictions as to the use of the river or even drive the industries away. Numerous instances of the latter can be cited.

NEPONSET RIVER AN ILLUSTRATION

One of the most interesting illustrations of the industrial wastes disposal problem is that of the Neponset River Valley near Boston in Massachusetts. This river rises about 22 miles from Boston Harbor into which it discharges. Its natural drainage area is 114.14 square miles and it also receives one-third of the flow of the Charles River at Dedham, equivalent to the drainage from 66.2 square miles. The total tributary area is therefore 180.3 square miles.

The normal yield of the drainage area is probably about as follows:

Month	Mil Gal. Daily	Cu. Ft. Per Sec.	Month	Mil Gal. Daily	Cu. Ft. Per Sec.
January	216	334	July	31	49
February	304	470	August	45	69
March	492	762	September	40	62
April	356	551	October	76	117
May	190	294	November	135	209
June	84	130	December	176	272
Mean				178	276

The actual flow is much more uniform than the natural flow would be because of the regulating effect of the storage reservoirs.

The State Department of Health reported at one time that there were about 30 mills discharging more or less wastes into this river. Before prohibitory statutes were passed, one wool scouring concern abandoned its location. Some manufacturers have diverted a portion of their business to other plants and one has abandoned the manufacture of one line of goods, thus avoiding the production of a large quantity of liquid wastes which were very difficult to treat.

Eleven manufacturers have provided sedimentation tanks and ten have constructed strainers and filters of cinders, coke or sand. Some have adopted chemical precipitation as a means of improving the efficiency of natural sedimentation. Treatment plants have been provided in nearly all cases where the wastes require treatment, some of which were described by the writer in a paper entitled "The Cleaning Up and Improvement of a Stream Polluted by Sewage and Trade Wastes," published in *Engineering and Contracting*, Aug. 9, 1916.

In 1902 the Massachusetts Legislature passed an act directing the State Board of Health,

"* * * * to prohibit the discharge of sewage * * * or every other substance which may be injurious to public health or may tend to create a public nuisance or to obstruct the flow of water, including all waste or refuse from any factory or other establishment where persons are employed, *unless the owner thereof shall use the best practicable and reasonably available means to render such waste or refuse harmless.*

"Section 2. The Board shall consult and advise with any such owner at his request or of its own motion as to the best practicable and reasonably available means of rendering such waste or refuse harmless, having regard to the circumstances and requirements of the situation and to the industrial interests involved." (Chap. 541, Acts of 1902.)

It is interesting to note that it was the intention at the time this original act was passed, to have reasonable regard for the manufacturing industries, not requiring them to go to extremes in the treatment of their wastes unless the exigencies of the situation required. In other words, incorporated into this statute was the "rule of reason."

At the time of the passage of this statute industrial wastes treatment in this country was in its infancy and progress in improvement of conditions in the Neponset Valley was naturally somewhat slow. In 1906 it appears that public sentiment had been so aroused that it was possible to pass an act in which the "rule of reason" was much less evident than in the earlier act. The only reference to it in the 1906 act was that the Board was to advise the owner of the factory as to the "*best practicable and reasonably available means of rendering the wastes or refuse harmless.*" The clause "having regard to the circumstances and requirements of the situation and to the industrial interests involved" was omitted from this act.

During the next 10 years many efforts were made to secure additional and usually more drastic legislation, in spite of the fact that the manufacturers expended large sums of money in an effort so to modify their wastes before their discharge that they should not endanger the public health nor tend to create a nuisance. Perhaps the culmination of these efforts may be said to have been embodied in a proposed act—Senate 113—presented to the Legislature for its consideration in the year 1916, which read as follows:

"Section 1. Any person, firm, corporation or group of individuals who shall cause, either directly or indirectly, the pollution of the waters of any river in this commonwealth, shall be punished by a fine of not more than one hundred dollars for every day which said pollution continues after notice from the health commissioner that such nuisance be abated.

"Section 2. A river shall be held to be polluted within the meaning of this act whenever by the introduction or discharge into its waters of any foreign or deleterious substance: (a) it shall give out any noxious or offensive smell, odor or vapor, which condition is a menace to the public

health; (b) it shall become discolored in such a way as to be unsightly or offensive, or (c) it shall become poisonous or dangerous to fish or animal life subsisting therein, or to live stock using the same as a drinking place; (d) it shall become injurious to vegetation in its vicinity.

"Section 3. The health commissioner of Massachusetts shall be charged with the enforcement of the provisions of this act and shall determine when the waters of any rivers are being polluted as aforesaid.

"Section 4. All acts or parts of acts inconsistent herewith are hereby repealed."

There are several provisions in this act which would be exceedingly oppressive if applied with literal interpretation of the act and without reading into it the rule of reason. One of these is the provision for a fine not to exceed $100, for every day which the pollution continues after notice from the Health Commissioner that such nuisances be abated. In some instances, even if prosecuted with diligence plants for the elimination of those ingredients of wastes which caused the pollution, could not have been built in less than six months' time.

Aside from the broad scope of the specifications of a polluted river within the meaning of this act, the Health Commissioner was charged with its enforcement and apparently made the sole judge to determine when the waters of the river were being polluted, as specified by the act. Should such an act be found constitutional, which is subject to some doubt, it would apparently deprive the alleged offenders of their rights to a hearing before the courts of justice.

Happily this act was not passed and is introduced here merely as an example of the extent to which industries or communities may go after they have become thoroughly aroused by long-continued objectionable conditions. It is confidently believed that such drastic legislation can always be avoided, and probably also its suggestion forestalled, by prudent foresight on the part of manufacturers in preventing objectionable conditions caused by the discharge of their untreated wastes.

PROGRAM FOR SOLUTION OF PROBLEM

In many cases where manufacturers have been confronted with a serious problem in connection with the disposal of their industrial wastes, they have been inclined to attempt its solution without first acquiring a clear understanding of the scientific principles involved, either in the production of the conditions which caused the trouble or in the processes available for the treatment of the wastes to render them less objectionable. The treatment of industrial wastes usually is a subject entirely different from that with which the manufacturers have to deal in their usual business and in which they are primarily interested, all other matters such as the treatment of their waste liquors, being of only secondary interest and importance from their point of view. They have, therefore, often adopted a plant poorly adapted to the use they desired to make of it. Sedimentation tanks, for example, are often found which are entirely inadequate for the purpose, although this process is most simple. All sorts of filters have been designed and constructed, but usually without the remotest conception of the scientific principles involved in the treatment which they were to accomplish.

Another fruitful source of misdirected energy has been the desire to recover from the wastes ingredients of value such, for example, as the grease and fertilizing ingredients in municipal sewage. Industrial wastes, like sewage, often contain ingredients which have a market value, and every encouragement should be afforded to the recovery of such products. As economic conditions change in the future there will be a greater need of economizing in this direction, and it is to be expected that processes will be devised for the profitable recovery of such ingredients. The fact that such processes may not be available at the time the problem first presents itself, but will probably be available at some future time, is not a justifiable reason for making no effort for its solution.

Whenever an industry is confronted with a problem of this kind a program for its solution should be carefully worked out before making expenditures upon construction. In fact, the studies necessary to the preparation of such a program may disclose other means of solution, involving relatively small cost.

First a study should be made of the waterway, to note its condition and physical characteristics, such as size, velocity of flow, depth and temperature, and a similar study of wastes to determine their quantity and character. With the information gained in this manner it will be possible to form an opinion as to the extent of treatment required to meet existing conditions.

Next, the kind of treatment and the plant required to provide such treatment, should be determined. The methods selected should be those required to give the results which may be desired within a reasonable period of time in the future when perhaps conditions may have become decidedly different from those obtaining at the time the investigation is made. Such methods should always be selected and reported with the clear reservation that better processes may subsequently be devised.

Following the selection of methods should be the construction of plant. Here it may be wise to proceed progressively, building first the system of drains required for the collection of the wastes and for their discharge at a single point. After this has been done further investigations based upon the measurement and analyses of the combined wastes, may be desirable. When the collecting system shall have been completed, it will be possible to provide the first part of the treatment process, such for example as screening or sedimentation. After this has been accomplished still further investigations may be desirable to determine, first, the efficiency of the plant already installed and, second, the next process of treatment which should be provided and the probable results to be obtained.

However much or little may be required, it is important to build in accordance with an intelligently devised plan and in harmony with such additional processes as may follow. Thus many expensive mistakes will be avoided and advantage taken of all opportunities to provide an economical arrangement of plant. The following of such a course will often result in avoiding expensive pumping of the wastes, or the treatment of excessive quantities due to the inclusion of relatively clean waters which may not require treatment under the local conditions.

The final step, and undoubtedly the most important, is the intelligent operation of the plant. Whether the processes involved are simple or complex the supervision and control of operation should be based upon a knowledge of the conditions in the river, the character of the wastes and the scientific principles involved in their treatment.

Synopsis of Recent Metallurgical and Chemical Literature

General Metallurgy

Recent Operations at the Consolidated Mining and Smelting Company.—In a paper given at the recent mining convention held in British Columbia, S. G. BLAYLOCK, general manager of the Consolidated Mining & Smelting Company, Trail, B. C., told of developments at his company's plant since the war started. Just before the war was declared and the markets were overflowed, and everyone expected a panic, the Consolidated Company had its vaults full of silver which it could not sell. Shortly after the war started, however, conditions began to improve and the markets and the stock exchanges started again and metals moved. Zinc jumped to a fabulous price. The company had been primarily a producer of lead, gold and silver. Some experiments had been conducted with zinc, but the men in charge of the work had enlisted. The experiments were started again, however, and a contract was taken on with the Imperial Munitions Board to make zinc. A plant was built, which cost a great deal more than was expected as so many things had to be changed as the process was perfected. At present about 40 tons per day of electrolytic zinc is being produced. A copper refinery was also built when the copper shortage became acute, and the company is producing 30 tons of refined copper per day. A copper converter plant was also constructed. Just about the time the copper plant was being built the company was notified by the concern from which it had been buying hydrofluosilicic acid for the lead refinery that it would either have to make a contract for three or four years ahead at about double the price or they would furnish no more. Hence a hydrofluosilicic acid plant was built and that necessitated a sulphuric acid plant, which was also built. These have been operating for several months. Since the building of the first sulphuric acid plant the requirements have increased so that the plant has been doubled. At present about 1600 men are employed and the following products are being made: electrolytic copper, copper sulphate, electrolytic lead, lead pipe, shrapnel, wire, electrolytic zinc, gold, silver, sulphuric acid and hydrofluosilicic acid. All of these with the exception of lead, gold and silver have been accomplished since the war started and were caused primarily by the need for the material by the Munitions Board. The author stated that 300 men—practically every unmarried Canadian or Britisher—had gone to the front.

Electrolytic Zinc

Difficulties in the Electrolytic Zinc Process.—At the recent mining convention held in British Columbia, Mr. THOMAS FRENCH of the Nelson Electrolytic Zinc Company, Nelson, B. C., read a paper on "Some of the Difficulties in the Electrolytic Zinc Process." He said one of the greatest difficulties both in early work and at the present time is in the roasting of ore so as to get a high extraction of the zinc. Mr. French's father, A. Gordon French, had used niter cake successfully in roasting and had obtained high total extractions, but it was later proven by the author to be unnecessary to use niter cake if certain precautions were taken in roasting. He said he had roasted a great number of ores and had generally obtained 90 per cent extraction. The Consolidated Company at Trail became interested in the process and made experiments in a large Wedge furnace, with seven hearths and 22 ft. 6 in. in diameter with high extractions. The author said he understood that the Consolidated Company was only obtaining 65 per cent extraction at present and that at Anaconda somewhat similar results are also being obtained. He thinks that these low extractions are due to improper roasting. The author stated that his father had found that manganese, contrary to the general opinion, was necessary in the zinc solution for the successful deposition of zinc. One of its main functions is to prevent the disintegration of the lead anodes. In addition to that the manganese has several other effects, such as giving a lower current consumption, and providing a valuable by-product of manganese dioxide. By the use of manganese the anodes are not absolutely protected, but with the addition of a little sulphate of soda the protection is absolute. Most of the manganese is deposited as manganese dioxide at the anodes and the remainder left in solution flows from electrolytic vats, along with the acid that has been set free, and is used again in the operation of dissolving the roasted ore, for the purification of the solution. In his father's Canadian patent specification dealing with the electrolytic part of the process he claims "the electrolyzing of a solution containing sulphate of zinc and sulphate of manganese for the recovery of zinc and of manganese." And also of a solution containing sulphate of zinc, sulphate of manganese, and sulphate of sodium for the recovery of zinc and of manganese dioxide. In the American patents, the claims—in order to save duplication of patents—are drawn up rather differently. They claim the electrolyzing of a solution containing sulphate of zinc, sulphate of manganese and sulphate of sodium. It was considered that it was quite safe to do that, as sulphate of sodium exists in practically every ore and collects in the solution.

Utilization of Waste Leather

London Chemical Industry Club Meeting.—An account of the first meeting of the new Chemical Industry Club in London is given in the *Chemical Trade Journal and Chemical Engineer*. The membership, for the present, is restricted to members of the London Section of the Society of Chemical Industry, and although among those who have signified their intention of joining are many living outside the London area, yet the general invitation of the committee of the club to all members of the section to attend the first meeting was responded to to such an extent as to fulfill the most sanguine expectations of those who are working so hard to make the new venture a success from the start. The actual membership at present is about 350, but a total of 500 is regarded as easily attainable, and there are one or two enthusiasts who feel that, with a subscription of only 2s. 6d., the whole of the 1000 members of the London Section should join. To assist the finances a number of donations have already been received. A paper was read by Mr. M. C. LAMB, and dealt with a subject upon which, at the request of the War Office, he has undertaken an investigation, viz., the commercial utilization of discarded army boots and other waste leather. The object of the paper was to incite the formulation of further suggestions for the utilization of this waste product on a commercially profitable scale.

The present policy of the Director of Army Contracts is to have old army boots sorted into four categories, the first three of which are sold for civilian use, and the remainder are available for waste. The actual quantity, which many of the members were anxious to know, was not stated by the author of the paper, the impression being not that he did not know, but that reasons of policy forbade the information being given. He indicated, however, several interesting directions in which experiments are being carried out to make use of discarded army boots. The most promising at the present moment is for the purpose of road-making. By dry distillation the quantity of charcoal obtained has been found to be about 25 per cent of the waste leather used. Then the uppers have been found to give some 15 per cent of extractable grease, and a quantity of crude ammonium sulphate has also been recovered. Another direction in which experiments have been made is in the treatment of the waste leather as an artificial manure; finely powdered and mixed with niter cake. However, not very successful results have been obtained, owing to the presence of soda salts. Decolorization carbon is another possible recovery, which should have commercial possibilities, having regard to the present shortage. Leather boards were also mentioned as likely to be attractive commercially, while a glue of inferior quality has also been evolved. Mr. Lamb's paper certainly created the interest which was desired. The use of waste leather in some of the directions indicated is not new, but the quantity which will be available from discarded army boots will be so large that considerably greater ingenuity may well be given to the problem in the knowledge that the supply will not fail for a very long time. Specimens of the by-products mentioned were shown to the members of the club.

Dust Collection and Ventilation

Dust Collecting and Ventilating in Factories.—In an address delivered on May 8, 1917, before the Illinois Manufacturers' Association and the National Safety Council, Mr. W. G. CLARK, president of the Clark Dust Collecting Company, Chicago, Ill., gave some interesting data on dust collection. Some of the most prominent industries in which dust collecting and ventilating systems can and should be used are as follows: Metal smelting and refining works, ore separating and mixing, carbide of calcium plants, crushing and grinding plants, cement mills—all departments, cereal mills, grain elevators, chemical works, gypsum works, hydrating plants, blast furnaces, graphite mills, asphalt manufacturing, flour mills, fertilizers, gum factories, cork factories, coal mines, phosphate plants, lead works, on sand-blast machines, malt houses, potteries, paint mills, shoe factories, polishing plants, wood-working factories, peat coal briquetting works, breweries, emery mills, foundries, collieries, gas works, drying plants, oxide plants, textile mills, sugar factories, jute mills, porcelain works, rubber factories, spinning mills, tanneries, tobacco factories, felt boot, tire factories, dextrine factories, munition plants, etc. Referring to metal smelting and refining works the author said there was a time when they let escape through the stacks from their furnaces valuable oxides and other valuable metals that they are now collecting and saving, and selling at a very fancy price, some places realizing a profit from $100 to $400 per day. In the cement industry there is a great deal of interest being taken in solving dust problems. There was a time when cement mills thought that dust was unavoidable, and that it was part of their business to have a lot of dust floating around, that it was part of the game, but in late years we notice a marked change in their opinion. Cement dust is valuable. They spend hundreds and thousands of dollars in pulverizing and grinding machinery to pulverize their raw and finished material into a fine powder such as cement is, and they figure it is foolish to let it escape and get away from them in this condition. Therefore, they are putting in dust systems to reclaim this fine dust. It reduces the cost of manufacture, and economical manufacturing of all products is looked after more carefully than in former years. They also figure that by eliminating the dust the sanitary condition is so much improved that it pays to have this improvement, as they secure a better day's work from their employees, and save wear and tear on their machinery. Irritating dust in sand blasting plants is also receiving the attention of all classes connected with this industry, from the State factory inspector, employee and employer. This is a very hazardous and very unsanitary business at its best, and the better condition existing in these industries the more work is accomplished, the less wear on men and machinery, and it is remarkable to see the interest that the conscientious employers are now displaying in this direction. On poisonous gases the same interest is being shown, and the U. S. Government is pushing the rigid investigation on poisonous dust, all of which combined with the willingness on the part of successful smelters are reaching grand results.

Aluminium

Action of Acetic Acid on Aluminium.—A paper on this subject was presented by RICHARD SELIGMAN and P. WILLIAMS at a recent meeting of the London Section of the Society of Chemical Industry and published in the April 30, 1917, issue of the *Journal* of the society. In an earlier paper (*Jr. Soc. Chem. Ind.*, 1916, 35, pg. 88) the action of boiling concentrated acetic acid was described. In the present paper the action of boiling acetic acid of lower concentrations and of acetic acid of all concentrations at ordinary temperatures is described. The action of boiling acids of lower concentrations has been found to be analogous to that of the solutions containing between 100 per cent and 50 per cent acetic acid previously examined, and it has been found that the rate of dissolution of the aluminium rises continuously until the concentration of the acid falls to 1 per cent. With acids of lower concentration than 1 per cent it is not possible to obtain reliable figures owing to the fact that the metal becomes coated with a protective skin which interferes with the action of the acid. Even with solutions containing 5 per cent acetic acid the numerical results become erratic owing to the same cause, but it is, nevertheless, possible to conclude definitely that where unprotected by a coating the aluminium dissolves at an ever-increasing rate.

"The rate of attack by cold acetic acid is in general small. As in the case of boiling acids, the rate of dissolution increases with increasing dilution of the acid, and the highest rate so far noted took place with a solution containing 0.02 per cent acetic acid. The rate of dissolution is frequently high at first, but rapidly falls off and then remains approximately constant over pro-

longed periods. This phenomenon has not been explained so far but does not appear to be of practical importance.

"In dealing with cold acetic acid it has been possible to show conclusively the effect of oxygen in promoting local action. Acids which normally cause local action of a serious kind can be made to act perfectly uniformly if the oxygen be entirely removed or if it be replaced by some inert gas. No doubt this accounts also for the fact that acids which in the cold or even at temperatures slightly below boiling point cause local action, nevertheless act perfectly uniformly at boiling temperatures when the oxygen is rapidly removed in the course of ebullition. In the case of cold acids it has been found, moreover, that the actual rate of dissolution is increased by the presence of oxygen, and may be reduced to less than half its original magnitude if the oxygen be replaced by hydrogen.

"Here again it may be well to point the practical moral of the observations made. Vessels used to contain solutions of these acids should not be allowed to remain wet for prolonged periods after being emptied and before cleaning. In such cases the metal is exposed to the action of thin films of acid subjected to intense aeration and, as practical experience has amply demonstrated, local attack frequently ensues. The metal should be purged as soon as possible of any remaining acid and, where practicable, left dry.

"One of the original objects of this research was to find an explanation of the fact that in stills used for the distillation of acetic acid the still proper was often found to have a prolonged life, whereas the condensers, notably in their lower part, were frequently subjected to rapid deterioration and to local perforation. It would appear that the effect of oxygen in promoting and localizing such attack affords a sufficient explanation of this phenomenon, because it is precisely at the point where this attack has been observed in condensers that oxygen would have access to surfaces bathed in hot acids.

"The question arises whether difficulties due to this cause could not be completely obviated by the introduction of some neutral gas at this point, or by preventing altogether access of oxygen to the condenser."

The effect of various foreign substances was also discussed by the authors. "It has been found that with dilute acids of about 10 per cent concentration the addition of up to 1 per cent of sodium chloride, potassium bromide, potassium iodide or potassium nitrate has practically no effect in the case of boiling acid, whereas an equivalent amount of sodium sulphate raises the rate of dissolution appreciably. In cold 10 per cent acetic acid, however, 1 per cent of sodium chloride is sufficient to raise the rate of dissolution tenfold, whereas potassium bromide effects a much smaller increase in the rate of attack, and potassium iodide and potassium nitrate none at all; 0.5 per cent of sulphuric acid in the form of sodium sulphate raises the rate of dissolution fourfold in the case of dilute acid at normal temperature.

"The most serious effect of the addition of the substances experimented with was noted in the case of 80 per cent acid at boiling point. Here the rate of dissolution is raised by 1 per cent of sodium chloride from 290 to 16,000. By 1 per cent of potassium bromide the rate is only increased from 290 to 485, while potassium iodide and potassium nitrate may be said to have no effect; 0.5 per cent of sulphuric acid in the form of sodium sulphate increases the rate of dissolution."

Molybdenum

Metallurgy of Molybdenum in Canada.—In *National Progress* for June, 1917, G. C. MACKENZIE gives some data on the development of the mining, concentration and reduction of molybdenum ores in Canada. Canadian molybdenum purchased by the Imperial Munitions Board of Ottawa in the form of molybdenite concentrates is being converted into ferromolybdenum in Canada before being exported to Europe, and as it is possible to manufacture the ferroalloy from concentrates containing less than 85 per cent MoS_2, the following scale of payment has been adopted: For concentrates containing not less than 85 per cent molybdenite, $1.09 per pound of contained MoS_2; not less than 80 per cent, $1.05 per pound MoS_2; not less than 75 per cent, $1.02 per pound MoS_2; not less than 70 per cent, $1 per pound MoS_2. The mining and metallurgical treatment of Canadian molybdenum ores has up to 1916 played a very small part in the world's production. This has been due to various factors, chief of which have been the limited demand for the mineral and the unattractive prices, together with the fact that no Canadian mine had until 1916 been developed to the point of a steady producer. The Department of Mines has conducted a large amount of experimental work on concentration and has finally adopted a modification of the Wood water film flotation machine (invented by Henry E. Wood of Denver, Col.), which is used on a semi-commercial scale in treating ores at the Department of Mines Laboratories. The plant has operated since June, 1916, and up to Feb. 1, 1917, has treated 2397 tons of crude ore and picked flake with the production of 34.85 tons of pure molybdenite in the form of a concentrate averaging 80 per cent MoS_2. The ore treated contained 1.84 per cent molybdenite and the actual molybdenite shipped has been 79.09 per cent of the total amount received. The total recovery would be slightly over 80 per cent, as no account has been taken in this calculation of the several tons of middling product in process of milling.

Among the companies who are operating in Canada to produce molybdenum are The International Molybdenum Company of Orillia, Ont., who are under contract with the Imperial Munitions Board; The Canadian Wood Molybdenite Company, The Spain Mines, County of Renfrew, The Chisholm Mine, The Renfrew Molybdenum Mines, in Ontario; The Molly Mine in the Kootenay, and The Molybdenum Mining & Reduction Company of Vancouver, British Columbia.

Among the processes used in the manufacture are the Elmore vacuum flotation process, the Minerals Separation process, the Hoover valveless apparatus, and the Callow pneumatic flotation process.

Technical Positions Announced by Civil Service Commission.—The present demand for technical men by the Government gives rise to the constant creation of new positions. At present physicists, metallurgists, chemists, geologists and metallographists are needed. Full information regarding these positions together with application blanks may be obtained from the Civil Service Commission in Washington, D. C., and from the secretaries of the Civil Service Boards in Boston, Philadelphia, Atlanta, Cincinnati, Chicago, St. Louis, Seattle, San Francisco, New York and New Orleans.

Recent Metallurgical and Chemical Patents

Soldering

Soldering Aluminium.—A composition for soldering aluminium is patented by Francis E. J. Litot, of Wilkinsburg, Pa. It consists of an alloy of zinc, lead, and tin in the proportions of 25, 55 and 45 parts respectively. This composition is claimed to form a solder which is very fluid and has a low melting point and is therefore suitable for soldering aluminium. It is also claimed to form a joint which has great endurance under either mechanical strains or weather, and its melting point is so low that danger of injuring the aluminium during soldering is entirely avoided, even in the hands of an unskilled workman. (1,224,941, May 8, 1917).

Iron and Steel

Process of Treating Iron Ores.—A process for treating iron ores, patented by Edward F. Goltra of St. Louis, Mo., consists essentially in preheating or calcining the ore and its gangue at a temperature and for a sufficient length of time to drive off the moisture in the ore and to render the gangue easily separable from the ore. The ore is subjected to vigorous tumbling which separates the gangue and the product in this shape is then subjected to a strong blast, which removes the gangue from the ore. The concentrated ore then is subjected to blast-furnace treatment. Fig. 1 illustrates

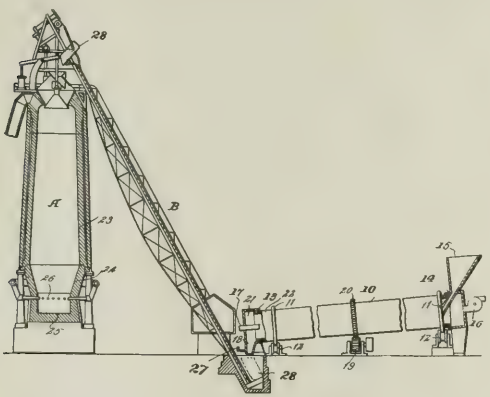


FIG. 1—GOLTRA'S PROCESS FOR TREATING IRON ORES.

the process. Ten is a rotating cylindrical kiln in which the ore is liberated from its moisture. At the lower end of this kiln is a burner and a blast pipe. The blast is intended to wash the charge and to penetrate in between the gangue and the values, loosening the latter from the gangue and in this manner making the whole product more suitable for blast furnace treatment. The rest is self-evident. (1,216,109, Feb. 13, 1917.)

Process for Making Ferro-Phosphorus.—John Jefferson Gray, Jr., of Rockdale, Tenn., has patented the making of ferro-phosphorus in a blast furnace. The process consists in charging the furnace with a suitable mixture of iron-bearing material, phosphatic material, fluxing material and excess carbon, the latter thus maintaining free uncombined carbon in the fusion zone. The temperature in the fusion zone should be high enough to reduce the phosphorus present in the phosphatic material to the elemental state in the presence of said free carbon. The temperature of the fusion zone is 2200 deg. Fahr. to 3100 deg. Fahr. This high temperature is produced by preheating the air blast to 900 deg. Fahr. The stock line temperature should not be higher than 700 deg. Fahr. The iron ore stack in the furnace should be high and have a slow downward motion so as to facilitate contact between the iron and the ascending phosphor vapor. (1,220,416, March 27, 1917.) A charge as used is given in the following table:

	Lb.	Lb.
Air		9,720
Phosphate rock:		
Tricalcium phosphate, $Ca_3P_2O_8$	1,050	
Calcium fluorid, CaF_2 / Calcium carbonate, $CaCO_3$ / Calcium sulfate, $CaSO_4$	224	
Silica, SiO_2	63	
Iron, Fe_2O_3	63	
Total phosphate rock		1,400
Iron ore:		
Fe	700	
SiO_2	252	
$Al_2O_3 + H_2O$	448	
Total iron ore		1,400
Silica, sand or flint:		
SiO_2	576	
K_2O	64	
Total		640
Coke, as carbon, C		1,840
		15,000

Copper, Lead and Zinc

Hydrometallurgy of Copper.—A patent to John H. Greenway, of Warren, Ariz., relates to the extraction of copper from ores and especially from oxidized ores. Sulphuric acid solutions are employed for the leaching. In general the process consists in passing a solution of sulphuric acid over ores containing copper and iron until the solution is substantially neutral. This neu-

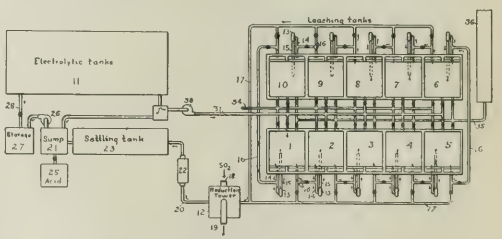


FIG. 2—GREENWAY'S PROCESS.

tral solution is then subjected to the action of sulphur dioxide which reduces the ferric sulphate to the ferrous state. The solution is then electrolyzed for the recovery of copper. The ferrous sulphate in the solution has no detrimental action on the deposition of the copper. Fig. 2 illustrates this process and needs no further explanation. (1,224,458, May 1, 1917.)

Electrolytic Zinc.—A patent has been granted to Urlyn Clifton Tainton of Johannesburg, Transvaal, South Africa, for the electrolytic recovery of zinc from ores or other zinc-bearing materials. One method of carrying out the process is as follows: The ore is first reduced to such a size as to render the zinc values readily accessible to the solvent. If the ore is sulphide it is primarily roasted to make it soluble in acid. The ore thus prepared is then treated with sulphuric acid. This may be effected by percolation, leaching or agitation, the last mentioned being preferred. The acid is added in quantities just sufficient to take up the zinc in the ore and leave a neutral solution. This solution is then freed from solid matter by filtration or settling

and a further amount of acid added. In filtering it is desirable to filter while hot so as to keep the zinc sulphate in solution. The acid and the zinc content should be fairly high, say 140 grams of zinc per liter and from 50 to 300 grams, preferably 75 grams of free sulphuric acid per liter. The solution then is electrolyzed with insoluble anodes such as lead and any suitable cathode. The amperage should be from 50 to 300 amp. per square foot. Usually the electrolysis is conducted until 60 grams of the zinc have been removed from the solution. The solution is then regenerated by dividing it into two portions such that one portion contains as much free acid as the whole of the original solution did before electrolysis. One portion of the solution is then kept separate while the other portion is used for dissolving fresh ore until it is again neutral. This solution, after filtering, is added to the portion kept separate bringing the whole solution up to standard conditions again. During the preparation of the solution iron is precipitated by the last amount of ore added to it to bring it to neutrality. This eliminates to a marked extent the accumulation of iron salts in the electrolyte. The quality of the metal deposited under these conditions, it is claimed, is very good and may be used directly as a galvanizing coating for the protection of iron against corrosion. If zinc is desired in the form of solid metal the cathodes must be of such a nature as to permit their stripping. The zinc then may be detached, melted and cast. If zinc sheet cathodes are used no stripping is required. (1,210,017, Dec. 26, 1916.)

Gold and Silver

Flotation and Cyanidation Combined.—HARRY LOUIS FRIBERGER, of Eureka, Kan., has patented the separation of the cyanicides by means of flotation before these have any detrimental action on the cyanide solution. To the ore, ground to the required fineness and mixed with the cyanide solution, a frothing medium is added. This latter is prepared by dissolving a resinous substance, such as rosin, in alcohol, the amount of rosin used being 25 and 50 per cent of the amount of alcohol used. To this solution is then added an amount of alkaline hydrate, best caustic soda, until the solution is neutralized. From this liquid the alcohol is distilled off and reused. The product left will be either liquid, semi-liquid or solid according to the amount of alcohol left in the product. The residue is soluble in water and acts as a satisfactory frothing medium. A typical example is given in the patent. The process as a whole is simply a combination of the regular cyaniding practice and flotation. Any practical type of machinery may be used. It is claimed that this practice gives a recovery of 90 per cent of the gold and 85 per cent of the silver. Often 95 per cent of the copper and as high as 80 per cent of the lead are floated. (1,224,917, May 8, 1917.)

Treatment of Refractory Auriferous Ores.—JOHN HENRY NIEMANN, of Adelaide, South Australia, has patented an improved method of economically extracting, separating and recovering the precious metal constituents of refractory auriferous ores containing selenium or seleniferous material yielding a salt or compound of selenium. Briefly the method consists in treating auriferous ores with a weak cyanide solution in the presence of seleniferous material under non-oxidizing conditions. The gold is then precipitated from the solution in slimes in a non-oxidizing atmosphere. The slimes are distilled to recover values other than gold and the gold residues are retorted under reducing conditions. (1,222,789, April 17, 1917.)

Alloys

Bearing Metal.—HENRY K. SANDELL of Chicago, Ill., has patented an improved bearing-metal alloy. The alloy consists of copper and antimony, in substantially the proportion of two parts by weight of the former to one of the latter, together with a small proportion of lead, and preferably in addition thereto a percentage of nickel. In general it appears that the antimony possesses the property of crystallizing the copper, thereby greatly increasing the hardness of the alloy and lowering the frictional resistance. The nickel toughens the alloy by binding together the highly crystalline mass, increasing thus the tensile strength and preventing disintegration under abrasive action. A typical alloy for supporting the steel shaft of a 10-kw. dynamo running 1800 r.p.m. would be, in parts of metal used, copper 4, antimony 2, lead 1 and nickel 1. It is claimed that alloys of this type will permit a bearing to run for an indefinite period without lubrication and without showing substantial wear. The alloy shows no overheating tendency, does not itself score or score the shaft and is in all respects satisfactory for use as a bearing-bushing operating under sliding friction, either without lubrication or with very little lubrication at moderate bearing pressure and high speeds. (1,223,001, April 17, 1917.)

Uranium

Uranium.—Two patents granted to CHARLES L. PARSONS, chief chemist of the Bureau of Mines, and dedicated for the free use of the people, have been granted for a process for the purifying of uranium compounds and for preparing oxides of uranium.

The process for the preparing of uranium oxide enables pure black oxide of uranium to be obtained for the use of producing ferro-uranium. Experiments in the production of uranium steel itself are now under way. By the use of the processes above mentioned the production of pure oxide of uranium is claimed to be very much facilitated and cheapened. Also the product is obtained in a much purer form than has ever been acquired heretofore. Uranium oxide so obtained is also valuable for coloring glass, giving to glass the golden yellow color seen in some of the newer forms of automobile headlights. The chief claims of the first patent (1,224,013) are as follows:

1. The process of preparing uranium dioxid, consisting in reducing a uranium compound in a fused bath with carbonaceous matter.

2. The process of preparing uranium dioxid, consisting in fusing a mixture of a uranium compound and a flux in the presence of carbonaceous material.

(6) The process of preparing uranium dioxid, consisting in fusing a mixture of finely divided alkali metal uranate, flux and carbonaceous matter, cooling, dissolving out soluble matter and washing the residue.

(7) The process of preparing uranium dioxid consisting in fusing a mixture of a uranate and a flux in the presence of a reducing agent, dissolving out soluble matter, washing successively with an alkali solution, water and an acid.

The chief claims of the second patent (1,224,014) are as follows:

1. The process of purifying uranium compounds, which consists in fusing the same with a flux incapable of forming a soluble compound with the uranium and then dissolving out the soluble matter.

2. The process of purifying uranates from vanadium and the like, consisting in fusing the uranate with a flux incapable of forming a soluble compound with the uranium, dissolving out the soluble matter and washing the residue.

(4) The process of purifying an alkali metal uranate, consisting in fusing the same with an alkali metal chlorid, and washing the resulting mass.

Organic Electrolysis

Electrolysis of Organic Compounds.—In order to minimize the disturbing effect of the inactive electrode in electrolyzing organic solutions, Dr. Alfred Piguet, of Basel, Switzerland, proposes to prevent the emulsion from reaching this electrode. The patent is assigned to the Society of Chemical Industry, of Basel, Switzerland. The result is obtained by reason of the difference in specific gravity of the electrolyte and of the specific gravity of the organic compound to be electrolyzed. If care is taken in choosing the difference in these specific gravities, sufficiently great, it is stated to be easy to produce a good emulsion in the neighborhood of the active electrode without the emulsion reaching the other electrode. An example of this method is given in the reduction of nitrobenzene to azobenzene, which is described as follows:

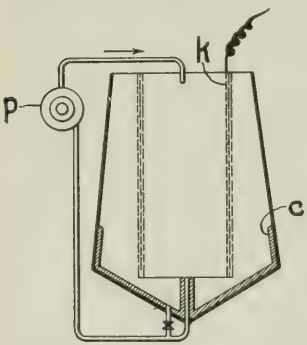


FIG. 3—ELECTROLYTIC CELL FOR ORGANIC SOLUTIONS.

"Into the middle part of a vessel of iron, having the form of a truncated cone (Fig. 3), which serves also as anode and has a conical bottom lined with a layer of cement *c*, is placed a cylinder *k* formed by several layers of iron-wire trellis acting also as cathode. The whole apparatus is filled up with soda lye of 2 to 5 per cent and with nitrobenzene, which latter sinks to the bottom of the recipient by reason of its higher specific gravity. A small rotatory pump *p* turning at a high speed causes the formation of the emulsion and the slow circulation through the cylindrical cathode. At the bottom of the vessel collects a mixture of azobenzene and nitrobenzene, which is maintained continuously in circulation by the pump. The reduction is achieved when all nitrobenzene has disappeared. The electrolysis is effected with 10 amp. per square decimeter and 2.5 to 3 volts at 85 to 95 deg. C."

Other processes mentioned are, preparation of hydrazobenzene from azobenzene, preparation of hydrazobenzene from nitrobenzene, preparation of hydrazotoluene, and oxidation of isoborneol to camphor. (1,225,052, May 8, 1917.)

Interesting Uses of Magnetic Separator Pulleys

Magnetic separator pulleys have been put to work in an increasingly large number of industries during the past 10 years. They are useful wherever it is desired to continuously remove the magnetic content from non-magnetic bulk material. For example, they are used with success in removing pickheads, coupling pins, etc., from coal passing to a crusher which would be damaged by the entrance of such material. They are used for similar purposes at phosphate rock mines and quarries. In the production of sulphite fibre paper stock, they are used to remove tramp iron and steel from the wood chips before these are delivered to the sulphite tanks. They are also used in the production of cement, gypsum, limestone, clay for terra cotta manufacture, as well as in the freeing of grain, spices and tobacco from bits of iron or steel before grinding. They also find employment in city refuse disposed plants, for removing tin cans, horse shoes, nails, etc., from the worthless material.

An example of an interesting application is found in the sugar industry, an industry in which it would seem there would be no need for such equipment. Magnetic separators made by the Cutler-Hammer Manufacturing Co., Milwaukee, Wis., and known as C-H magnetic separators are in use in a large number of sugar plants, a report on the use in one, the Revere Sugar Refining Co. plant, giving an idea of the work done in this industry.

The separator in this plant is installed to remove iron rust or iron oxide from animal charcoal which is collected by it while passing through the ovens and being baked. This baking process is necessary to eliminate from the charcoal the impurities which it has absorbed from the sugar. The magnetic material is especially prevalent after the retort has been repaired. Under ordinary conditions the magnetic pulley is energized only part of the time, two weeks out of a month or so, this being sufficient to keep the iron oxide out of the bone charcoal so that trouble with iron coloring in the sugar is prevented.

The magnetic pulley in this installation is placed in the delivery end of the conveyor which carries the animal charcoal from the retorts to the elevator. The material from which the iron content is to be removed is carried about 1 in. deep on the belt, the separator pulley revolving at about 50 r.p.m. and handling 5000 cu. ft. of charcoal in 24 hours.

The use of powdered or pulverized fuel has been

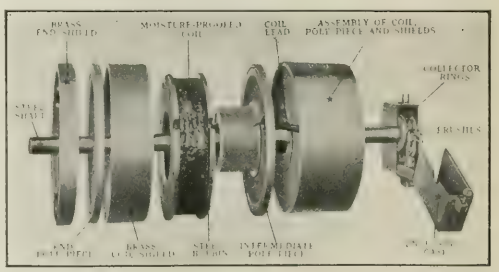


FIG. 1—EXPLODED VIEW OF C-H MAGNETIC SEPARATOR PULLEY.

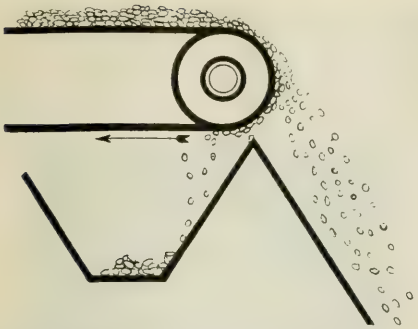


FIG. 2.—PRINCIPLE OF MAGNETIC SEPARATOR PULLEYS.

extended and this has led to the need of magnetic separators in cement plants, steel plants, powerhouses and many other kinds of plants. For open hearth furnaces, a brief mention is made here of the process of furnishing the pulverized coal and the use of the magnetic separator.

First the tramp iron is removed from the coal by means of magnetic separators. Coal as delivered to the milling plant always contains an astonishing amount of tramp iron in the form of bolts, nuts, rivets, nails, bar iron, railroad spikes, mule shoes, etc. Any of these materials entering the crusher or pulverizer might result in damage to the machine, with consequent delays in operation.

This foreign magnetic material can be entirely eliminated by the use of a magnetic separator located at some point ahead of the crusher. When the material passes over the above pulley which contains the magnet, the magnetic material, consisting of tramp iron, is attracted and held firmly against the belt and remains in contact with the belt until it leaves the magnetized zone, which is at some point beyond the under side of the magnetic pulley. The tramp iron drops from the belt after it leaves the pulley and is delivered to suitable boxes by means of a chute, the coal continuing on its course.

The shortage of natural gas caused the Missouri, Kansas & Texas Railroad to decide upon pulverized fuel for the water tube boilers in the powerhouse of the shops at Parsons, Kan. The equipment for pulverizing and drying fuel is contained in a separate building, which is located near one end of the boiler house, and the coal is dumped from the cars directly into a concrete track hopper adjoining this building. The plant is designed to handle either mine run or slack coal and immediately below the track hopper is placed a set of rolls, which reduce lumps up to 12 in. by 18 in. to 5-in. cubes or less in one operation. As the coal passes through this crusher it drops onto a belt conveyor, which discharges directly into a set of corrugated rolls. The upper end of the belt conveyor passes over a 24-in. by 22-in. Cutler-Hammer magnetic separator pulley, the function of which is to remove any pieces of iron or steel which may be in the coal and retain them on the belt until the latter passes off the underside of the pulley, the metal then dropping to the floor behind the crusher. This crusher reduces the coal to pass through a ¾-in. mesh or less and delivers it into a dust-tight elevator, from which it is distributed into a storage bin.

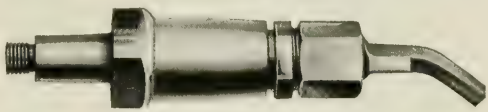
Furnishing powdered coal as a locomotive fuel by the Santa Fe made necessary a crushing plant and magnetic separator at Marceline, Mo. Here the coal (mine screenings) is fed through a drier, at the discharge end of which there is located a separator which takes out any tramp iron which may be in the coal.

The pulley is magnetized by passing direct current through the windings in the interior of the pulley.

Oxy-Acetylene Rivet Cutting

For cutting off rivet heads and stay-bolts flush with plates by the oxy-acetylene process, it is desirable to have a cutting tip so designed as to permit of the gas jet playing parallel with the plates.

To meet this need The Prest-O-Lite Company, Inc., of Indianapolis, Ind., is manufacturing a special rivet and stay-bolt cutting attachment. This attachment is



RIVET CUTTING ATTACHMENT.

used in connection with the Type K cutting blow-pipe shown, being screwed into the head in place of the regular cutting nozzles. The copper tip is bent at a convenient angle and is adjustable to any position, facilitating operation in close quarters.

Much cleaner work in rivet and stay-bolt cutting is possible with this attachment than with standard cutting tips which do not permit of a cut truly parallel with the plates.

Personal

Mr. **Francis B. Coyle**, metallurgist for the New Departure Manufacturing Company, Bristol, Conn., has resigned to assume new duties as metallurgical engineer for the Greenfield Tap & Die Corporation, Greenfield, Mass.

Mr. **J. R. Flannery** of Pittsburgh, Pa., president of the American Vanadian Company and the American Flexible Boat Company, has gone to Washington, D. C., to work with Henry P. Davison of J. P. Morgan & Co. on problems connected with the American Red Cross.

Messrs. **Ainslie Gray** and **Charles Benjamin** announce that they have formed a partnership, to be known as Gray & Benjamin, to act as advertising counsel to manufacturers of electrical, mechanical, chemical and kindred products. Their office will be in the Transportation Building, 608 South Dearborn Street, Chicago. Mr. Gray was formerly managing editor of *Electrical Review and Western Electrician*, and has been president of the Associated Business Papers, Inc. Mr. Benjamin was the first editor of *Printers' Ink*, and from 1906 to 1915 was advertising manager of the Cutler-Hammer Manufacturing Company of Milwaukee, Wis.

Frederic DeP. Hone & Co., engineers, announce the removal of their office to 13-21 Park Row, New York City.

Mr. **Philip N. Moore**, president of the American Institute of Mining Engineers, has completed visits to

several of the Western sections of the society and has returned to St. Louis.

Mr. **Louis Rasmussen** has resigned as superintendent of the Wisconsin Aluminum Foundry Company, Manitowoc, Wis., to take up other duties in Marshalltown, Iowa. He was tendered a banquet by the officers and employees of the company.

Dr. **A. W. Schorger,** who for seven years has been connected with the Forest Products Laboratory, Madison, Wis., has resigned to take charge of organic chemistry with the C. F. Burgess Laboratories at Madison, Wis. The Burgess Laboratories are actively engaged at present upon problems of national preparedness and defense, and are represented on both national and state committees. Dr. Schorger's immediate duties will be in connection with some of these problems, especially those relating to foodstuffs.

Mr. **H. N. Stronck** has been appointed vice-president and managing engineer of the Illinois Engineering, Auditing & Public Relations Company, 122 South Michigan Avenue, Chicago, this firm being successors to Benedict, Boyle & Stronck, Inc., and is engaged in general consulting business on engineering, construction, industrial economics, public relations, accounting and auditing.

Mr. **Maurice R. Thompson** of the Power and Mining Department, General Electric Company, Schenectady, N. Y., spent May and June at the new electrolytic zinc plant of the Judge Mining & Smelting Company at Park City, Utah. He will return to Schenectady via Butte, Great Falls and Trail, B. C.

Mr. **R. E. Vandruff,** president of the New Dominion Copper Company, was recently at Globe, Ariz., inspecting the properties of the company.

Mr. **John B. Wise,** superintendent of the electrolytic and acid plant of the Chile Exploration Company, Chuquicamata, Chile, will be in the United States on his vacation from June 15 to Sept. 15 of this year.

Book Review

The Mining Manual and Mining Year Book, 1917. By **Walter R. Skinner.** 960 pages. Price 15s., net. Post free; outside of England 17s., net. London: Walter R. Skinner.

This is the thirty-first consecutive yearly issue of this valuable handbook of mining companies, engineers and directors. The work includes all mines whose shares are dealt in on the London Stock Exchange and many others, including many of the large American companies. The number of companies listed is 1710 and a supplementary list gives references to former volumes on 2286 additional companies. All the regular features of the work are included. In the preface a review is given of conditions throughout the world during the past year. The previous high standard of this book is maintained in this issue, and it should prove of great value to those who wish to be well informed on foreign mining.

Obituary

Alois von Isakovics, the well known proprietor of the Synfleur Scientific Laboratories, passed away at his home in Monticello, N. Y., on June 4. Mr. von Isakovics was born at Prague, Austria, in 1870, and came to this country when he was about sixteen years old. After he had been here several years he founded the Herbene Chemical Co., in Harlem. In 1895 he married Mary Upschur, whose home was in the Southern States. In 1904 he went to Monticello, N. Y., where he founded the Syn-

THE LATE ALOIS VON ISAKOVICS

fleur Scientific Laboratories. The business flourished and the company became very well known in the manufacture of perfumes, flavoring extracts, essential oils, and other chemicals. Mr. von Isakovics was a prominent member of the Perfumers' Association and was formerly active in the American Electrochemical Society. He delivered many lectures before the chemical and pharmaceutical classes in several of the large universities.

Edward R. Taylor, the distinguished inventor of the continuous electric furnace process for the manufacture of carbon bisulphide and one of the pioneers of electrochemistry in this country, passed away at his home in Penn Yan, N. Y., on May 28. Mr. Taylor was born in

THE LATE EDWARD R. TAYLOR

St. Lawrence County, New York, in 1844, and was educated in England and America. He graduated from the Lawrence Scientific School of Harvard University in 1868. He was a professor of chemistry at the Homeopathic Hospital College in Cleveland from 1869-73, and chemist with the Cleveland Rolling Mill Company from 1869-76. He was president of the Taylor Chemical Company in Penn Yan for many years, relinquishing it a few years ago to his son, Dr. Charles Taylor. The manufacture of carbon bisulphide was commenced about 1899.

Mr. Taylor was a member of the American Electrochemical Society, American Chemical Society, American Institute of Chemical Engineers, Society of Chemical Industry and American Institute of Electrical Engineers.

CURRENT MARKET REPORTS

The Iron and Steel Market

The character of the steel market has changed entirely in the past few weeks, fully attaining the development that was referred to briefly in our last report. The business being done is of considerably smaller volume than even a fortnight ago, and is of much smaller volume than that of a few months ago. The character is altogether altered, as the buying is chiefly for what may be called early deliveries, in that they are earlier than most of the large mills can make as they are already filled with other business. The buying for distant deliveries, what came to be known last year as "delivery at mill convenience" has become inconsequential, and there are no market prices quotable. As a result, the only market that is quotable becomes the market for the earlier deliveries, in from three to six months, roughly speaking. Such prices are higher than would rule for the later deliveries, if there were such prices, and thus by a change in the nomenclature, or in the "argument" as the astronomer would put it, the market appears to have advanced more than it really has.

Prices currently quoted as representing the market are, for instance, 8c. to 9c. for blue annealed and black sheets, 4.25c. or 4.50c. for merchant bars and structural shapes, 8c. to 9c. for tank plate, and so on. These are the prices ruling on such business as is being done, but the business is largely of the emergency character. There is not represented, in the buying, any considerable amount of new construction, of car building, and the like. It is a market that cannot be maintained indefinitely unless an extremely large part of the steel output is diverted to war purposes, and of course at reasonable prices as provided by law for Government purchases. The rank and file of consumers cannot continue to do business if they must eventually pay the prices now quoted as the market.

The steel market, however, can get along for quite a while without a break, because the great bulk of the steel being shipped is invoiced at prices much below the current market. Striking an average of the various finished steel products, steel that was bought on the first of last October, and some undelivered steel was bought before that, was $50 a ton below the present market, while steel bought on Feb. 1, the date of the German submarine announcement, was about $36 below the present market.

The United States Steel Corporation has total tonnage obligations on its books, although variously distributed in the different departments, equal to its total output for about nine and a half months. The independents as a whole are booked to a somewhat smaller proportion of their capacity. As the Government places orders for steel, to be given precedence, and to the extent of 25 per cent, 40 per cent, or possibly even more of the output, the time in which the existing orders can be filled will be greatly lengthened.

Without doubt there is a slowing down in the consumption of steel. Building engagements have almost ceased. Even in May the fabricated steel contracts taken by the Bridge Builders' and Structural Society represented only 56½ per cent of the fabricating capacity. Railroad buying has practically ceased. Some of the automobile makers have materially curtailed their specifications for steel, with prospects of greater curtailment. Ford and a few others are, however, requiring more steel than they expected.

There is a great deal of newspaper talk about prices to be paid by the Government for steel, but the actual negotiations are very quietly conducted and the facts may never be fully known. The subject has been greatly confused by making comparisons of possible prices for the Government with prices now ruling on small lots for early delivery, paid by distressed buyers. It would be no strain whatever to the steel industry for the Government prices to be very much lower than the present quoted which are altogether fictitious as representing a real and broad market.

THE PIG IRON ADVANCE

At the time of last report the pig iron market was advancing wildly. It has since been advancing more conservatively, but still rather steadily, say at the rate of $1 to $2 per ton per week instead of $2 to $5. The $50 mark has been passed in some districts and not in others. The buying has been checked to a considerable extent as buyers realize the great risks incurred in purchasing for the first half of 1918, and there is little business left to be done for the remainder of this year.

The peculiar feature of the situation is that with pig iron at more than double the price it has reached in a third of a century there are some blast furnaces that are losing money, because they are still delivering pig iron sold last August and September at $18 and thereabouts, when costs have mounted very sharply, particularly because furnace coke must frequently be bought for spot shipment, to eke out the insufficient deliveries on contracts. Thus the blast furnaces have their future before them.

Non-Ferrous Metal Market

Monday, June 25.—There is practically no change in the copper market, pending Government developments. Tin has advanced during the last few weeks and lead remains strong. Spelter has been dull and antimony declined slightly. Silver has been strong and has advanced again.

Copper.—There is practically no change in the copper market and prompt electrolytic still rules around 32.50 cents with Lake at 31.00 to 31.50. A member of the Council of National Defense has stated that the Government ought not to pay more than 20 cents for copper but no definite action has been taken on the Government price as yet. It is understood that the Fed-

eral Trade Commission intends to make an investigation of the cost of producing copper.

Tin.—Straits tin has been scarce for prompt delivery and advanced from 60.75 on June 11 to 64.00 cents on June 19. It has since fallen off to 63.50. No special developments have been noted.

Spelter.—The spelter market has been characterized by its usual dulness and prices remain virtually unchanged. Prompt spelter has sold for 9.30 to 9.55 cents and these prices have remained steady during the last two weeks.

Lead.—The trust price of lead remains at 11.00 cents, New York, with the outside market asking 11.75 to 12.00 cents. The Government has purchased 8600 tons for which it is said to have paid 8 cents, St. Louis. The Government is expected to require 100,000 tons per year.

Other Metals.—Aluminium is unchanged at 59.00 to 61.00 cents for No. 1 Virgin. The Aluminium Company of America has offered to supply the Government at 27.50 cents per pound. Antimony has declined from 20.25 to 19.25 cents for spot. Magnesium can be had at 2.00 to 2.50 per pound. Quicksilver is $80 to $82. Platinum is $105, cobalt, $1.70 and silver 78½. Tungsten concentrates are $20.00-$22.00.

Chemical Market

Benzol.—Stocks of prompt benzol have generally been more than sufficient to answer the requirements of the trade but consumers have not been inclined to take hold to any great extent. Prices have held fairly well although they rule lower for the interval. Contracts are now available at attractive prices.

Toluol.—One cheap lot of resale material tended to lower values during the interval but aside from this fact prices have held rather well although the volume of business transacted has not been large. At the moment of writing the market has assumed a somewhat steadier aspect.

Phenol.—A production in excess of the demand continues and the market has eased off somewhat during the interval. The general situation is unsatisfactory from every viewpoint. A small export inquiry has developed but this has not materialized any important transactions.

Naphthaline.—This product has been offered more freely and balls in particular have been in abundant supply after a scarcity of some months. Flakes have also been offered more freely. The production continues on a large scale.

Beta Naphthol.—One manufacturer who discontinued the production of this product offered considerable quantities of surplus material at low prices during interval but these sales were not necessarily a reflection of general conditions. As a matter of fact the undertone is stronger due to the sharp advance in caustic soda.

Benzoic Acid.—A very large production of this material is noted at the present time and there are probably close to twenty firms producing the material either in glass or in a larger way. The season for large buying is now at hand but prices show but little evidence of this. Offers have been made and continue to be made on a very low basis, one, in fact that can allow but little encouragement to substantial producers. Some of the benzoic acid being produced leaves much to be desired. Practically the same conditions prevail in the *benzoate of soda market.* Production is large and prices have consequently dropped sharply.

Salicylates.—A pronounced scarcity is noted for salicylic acid and the *salicylates* and prices have advanced to high levels with supplies very difficult to secure. The tendency is still higher.

Monochlorbenzol.—A larger production has resulted in very free offerings with prices at a comparatively low level. There does not appear to be any immediate indication of an advance.

Dinitrophenol.—Spot supplies have been replenished and prices have receded with trading more restricted.

Caustic soda.—The market has climbed to even a higher level than when we last reported both for spot and contract and the speculative interest has been very active. Ground caustic continues very scarce and high. *Soda ash* has remained firm and active and owing to the fact that steamship companies have been refusing the product packed in ordinary barrels, hard wood casks have been in heavy demand for this style shipping.

Barium products.—There has been important inquiry for practically all barium compounds particularly *carbonate.* A production of *chlorate of barium* is being made here for the navy.

Copper sulphate.—Blue vitriol has been quiet with comparatively unimportant business. The export movement has not been large and has been principally to France and Spain as heretofore.

Cyanides.—With the exception of the potassium salt, all *cyanides* have been weaker and slow in movement. *Potassium,* however, is scarce and high.

Acids.—The situation generally is stronger. There have been no weak sellers. *Nitric* has been particularly strong although business has not been important. *Brimstone sulphuric acid* is revealing much firmness owing to the strong position of brimstone. *Muriatic acid* is also higher and rather more active.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JUNE 22, 1917

Acetic anhydride	lb.	1 70	—	1 90
Acetone, drums	lb.	.27	—	.27½
Acid, acetic, 28 per cent	lb.	.05	—	.05½
Acetic, 56 per cent	lb.	.10	—	.11
Acetic, glacial, 99½ per cent, carboys	lb.	.35	—	.37
Boric, crystals	lb.	.13	—	.13½
Citric, crystals	lb.	.73½	—	.75
Hydrochloric, commercial, 18 deg	lb.	.01⅜	—	.01½
Hydrochloric, 20 deg	lb.	.01½	—	.01¾
Hydrochloric, C. P., conc., 22 deg	lb.	.01⅝	—	.01¾
Hydrofluoric, 30 per cent, in 1 arrels	lb.	.04¾	—	.05
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.04½	—	.05
Nitric, 36 deg	lb.	.07	—	.07½
Nitric, 42 deg	lb.	.08	—	.08¼
Oxalic, crystals	lb.	.46	—	.47
Phosphoric, 85 per cent	lb.	.33	—	.37
Picric	lb.	.70	—	.75
Pyrogallic, resublimed	lb.	3 50	—	4.00
Sulphuric, 60 deg	ton	22 00	—	24.00
Sulphuric, 66 deg	ton	30 00	—	35.00
Sulphuric, oleum (Fuming), tank cars	ton	38.00	—	40 00
Tannic, U. S. P., bulk	lb.	.45	—	.50
Tartaric, crystals	lb.	.81	—	.82
Alcohol, grain, 188 proof	gal.	3.06	—	3.08
Alcohol, wood, 95 per cent	gal.	1.00	—	1 02
Alcohol, denatured, 180 proof	gal.	.72	—	.73
Alum, ammonia lump	lb.	.04¼	—	.04¾
Alum, chrome ammonium	lb.	.18	—	.19
Alum, chrome potassium	lb.	.30	—	.32
Alum, chrome sodium	lb.	.12	—	.12½
Alum, potash lump	lb.	.06½	—	.07
Aluminium sulphate, technical	lb.	.02	—	.02½
Aluminium sulphate, iron free	lb.	.03	—	.03¼
Ammonia aqua, 26 deg. carboys	lb.	.07	—	.07½
Ammonium carbonate	lb.	.13	—	.14
Ammonium nitrate	lb.	.16	—	.17
Ammonium, sulphate domestic	100 lb.	6.25	—	6.35
Amyl acetate	gal.	4 50	—	4.60
Arsenic, white	lb.	.19	—	.20
Arsenic, red	lb.	.30	—	.60
Barium chloride	ton	80 00	—	90 00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.11	—	.11½
Barium peroxide, 80 per cent	lb.	.27	—	.27½

Bleaching powder, 35 per cent chlorine	lb.	02	—	02½
Borax, crystals, sacks	lb.	04¼	—	08
Brimstone, crude	ton	45 00	—	
Bromine, technical	lb.	80	—	90
Calcium, acetate, crude	lb.	03	—	03½
Calcium, carbide	ton	80 00	—	90 00
Calcium chloride, 70-75 per cent, fused, lump	ton	26 00	—	28 00
Calcium peroxide	lb.	1 60	—	1 65
Calcium phosphate	lb.	30	—	31
Calcium sulphate	lb.	10	—	12
Carbon bisulphide	lb.	04¼	—	04½
Carbon tetrachloride, drums	lb.	16	—	16½
Caustic potash, 88-92 per cent	lb.	85	—	86
Caustic soda, 76 per cent	100 lb.	6.75	—	6.85
Chlorine, liquid	lb.	15	—	18
Cobalt oxide	lb.	1 55	—	1 60
Copperas	100 lb.	1 00	—	1.05
Copper carbonate	lb.	30	—	32
Copper cyanide	lb.	72	—	74
Copper sulphate, 99 per cent, large crystals	lb.	09½	—	10
Cream of tartar, crystals	lb.	48	—	49
Epsom salt, bags	100 lb.	4 25	—	4 50
Formaldehyde, 40 per cent	lb.	17	—	18
Glauber's salt	100 lb.	65	—	70
Glycerine, bulk, C. P	lb.	61	—	62
Iodine, resublimed	lb.	3 50	—	
Iron oxide	lb.	02	—	08
Lead, acetate, white crystals	lb.	16	—	17
Lead arsenate	lb.	12¾	—	13½
Lead nitrate	lb.	17½	—	18
Litharge, American	lb.	08	—	19
Lithium carbonate	lb.	1 02	—	1.05
Manganese dioxide, U. S. P.	lb.	55	—	60
Magnesium carbonate, tech	lb.	13½	—	14
Nickel salt, single	lb.	14	—	14½
Nickel salt, double	lb.	11	—	12
Phosphorus, red	lb.	1 15	—	1 20
Phosphorus, yellow	lb.	1 90	—	2 00
Potassium bichromate	lb.	35½	—	36
Potassium bromide granular	lb.	1 00	—	1.05
Potassium carbonate calcined, 80-85 per cent	lb.	70	—	.75
Potassium chlorate, crystals	lb.	54	—	55
Potassium cyanide, 98-99 per cent	lb.	2 20	—	2 25
Potassium iodide	lb.	2 90	—	2 92
Potassium muriate 80-85 p. c. basis of 80 p. c	ton	360 00	—	365 00
Potassium nitrate	lb.	31	—	33
Potassium permanganate	lb.	4 00	—	4 10
Potassium prussiate, red	lb.	2 50	—	2 55
Potassium prussiate, yellow	lb.	96	—	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	350 00	—	375 00
Rochelle salts	lb.	37½	—	38½
Sal ammonia, gray gran	lb.	10	—	11
Sal ammoniac, white gran	lb.	15	—	16
Sal soda	100 lb.	8 1 20	—	1 25
Salt cake	100 lb.	90	—	1 00
Silver cyanide	oz.	70	—	
Silver nitrate	oz.	47⅞	—	
Soda ash, 58 per cent, light, flat	100 lb.	2 75	—	2 85
Soda ash, 58 per cent, dense, flat	100 lb.	3 90	—	4 00
Sodium acetate	lb.	09	—	10
Sodium benzoate	lb.	4 75	—	5 50
Sodium bicarbonate, domestic	100 lb.	2 30	—	2 50
Sodium bicarbonate, English	lb.			
Sodium bichromate	lb.	15½	—	16
Sodium bisulphite, powd	lb.	03½	—	04
Sodium chlorate	lb.	24	—	26
Sodium cyanide	lb.	65	—	70
Sodium fluoride, commercial	lb.	13	—	14
Sodium hyposulphite	lb.	01¾	—	02
Sodium nitrate, refined	lb.	06	—	06¼
Sodium nitrite	lb.	49	—	55
Sodium peroxide	lb.	90	—	95
Sodium phosphate (tri.)	lb.	04¾	—	05
Sodium prussiate, yellow	lb.	29½	—	30½
Sodium silicate, liquid—40 d. g. B. and	100 lb.	1 50	—	1.60
Sodium sulphide, 30 per cent crystals	100 lb.	1 65	—	1.75
Sodium sulphide, 60 per cent, fused	100 lb.	2 90	—	3.25
Sodium sulphite	lb.	03¼	—	03½
Strontium nitrate	lb.	28	—	30
Sulphur chloride, drums	lb.	06	—	06½
Sulphur dioxide, liquid, in cylinders	lb.	15	—	20
Sulphur, flowers, sublimed	100 lb.	3 20	—	3.30
Sulphur, roll	100 lb.	2 55	—	2.60
Sulphur, crude	ton	45 00	—	46 00
Tin bichloride, 50 deg	lb.	19¾	—	20
Tin oxide	lb.	64½	—	65
Tungstic acid, basis 100 per cent	lb.	1 40	—	1.50
Zinc carbonate	lb.	25	—	27
Zinc chloride	lb.	10¼	—	11
Zinc cyanide	lb.	50	—	
Zinc dust, 350 mesh	lb.	18	—	20
Zinc oxide, American process XX	lb.	15	—	15½
Zinc sulphate	lb.	06	—	06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	55	—	60
Benzol, 90 per cent	gal.	57	—	59
Toluol, pure, water white	gal.	1 80	—	1 90
Xylol, pure, water white	gal.	50	—	55
Solvent naphtha, water white	gal.	19	—	21
Solvent naphtha, crude, heavy	gal.	13	—	16
Creosote oil, 25 per cent	gal.	31	—	33
Dip oil, 20 per cent	gal.	29	—	30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	55	—	60
Carbolic acid, crude, 25 per cent	lb.	32	—	35
Cresol, U. S. P.	lb.	25	—	

Intermediates, Etc.

Alpha naphthylamine	lb.	90	—	1 05
Aniline oil	lb.	29	—	31
Aniline salts	lb.	34	—	35
Anthracene, 80 per cent	lb.	10	—	
Benzaldehyde	lb.	4 50	—	5.00
Benzidine, base	lb.	1.85	—	2.00
Benzidine, sulphate	lb.	1.55	—	1.60
Benzoic acid	lb.	5 00	—	5 50
Benzyl chloride	lb.	2 00	—	2 10
Beta naphthol benzoate	lb.	11 00	—	12 00
Beta naphthol, sublimed	lb.	70	—	.75
Beta naphthylamine crude	lb.	2 50	—	
Dichlor benzol	lb.	.22	—	23
Dinitrochlorbenzol	lb.	46	—	48
Dimethylaniline	lb.	.55	—	60
Diphenylamine	lb.	95	—	1.00
H-acid	lb.	3.25	—	3.50
Metaphenylenediamine	lb.	1 70	—	1.75
Monochlorbenzol	lb.	26	—	.28
Naphthalene, flake	lb.	09½	—	10
Naphthionic acid, crude	lb.	1.50	—	1 75
Nitro naphthaline	lb.	45	—	50
Nitro toluol	lb.	50	—	55
Ortho-amidophenol	lb.			
Ortho-toluidine	lb.	1 00	—	1 15
Para-amidophenol, base	lb.	5.00	—	6 00
Paranitraniline	lb.	1 10	—	1 15
Paraphenylenediamine	lb.	3 75	—	4 00
Para toluidine	lb.	1.90	—	2 00
Phenol, U. S. P.	lb.	.40	—	42
Resorcin, technical	lb.	8 50	—	9 00
Resorcin, pure	lb.	16.00	—	17 00
Salicylic acid	lb.	1 35	—	1 45
Salol	lb.	1 85	—	2 00
Sulphanilic acid	lb.	.32	—	33
Toluin	lb.	3 00	—	
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.10	—	....
Corning, Ohio	bbl.	2.40	—	....
Somerset, Ky	bbl.	2.20	—	....
Wooster, Ohio	bbl.	2.18	—	....
Indiana	bbl.	1.78	—	....
Illinois	bbl.	1.92	—	....
Oklahoma and Kansas	bbl.	1 70	—	....
Caddo, La., light	bbl.	1.90	—	....
Corsicana, Tex., light	bbl.	1.70	—	....
California	bbl.	.88	—	1 22
Gulf Coast	bbl.	1.00	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13½	—	.14
Cylinder, light	gal.	.21	—	26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	29½	—	.30
Paraffine, .903 sp. gr	gal.	21½	—	22
Paraffine, .865 sp. gr	gal.	18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	....
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....

Vegetable and Other Oils

China wood oil	lb.	16½	—	16¾
Cottonseed oil, crude	gal.	1 11	—	
Linseed oil, raw, cars	gal.	1 17	—	
Peanut oil, crude	gal.	1 15	—	
Rosin oil, first run	gal.	.38	—	....
Rosin oil, fourth run	gal.	.67	—	....
Soya bean oil, Manchuria	lb.	14½	—	....
Turpentine, spirits	gal.	.43	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40 00
Barytes, floated, white, domestic	ton	28 00	—	32.00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, flor	lb.	.53	—	
Casein	lb.	.19	—	.28
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American	lb.	.35	—	
Red lead, dry, carloads	lb.	.13	—	
Rosin, 280 lb	bbl.	6.15	—	
Soapstone	ton	10 00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	11½	—	

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	60.00	—	....
Clay brick 1st quality fireclay	per 1000	45.00	—	....
Clay brick, second quality	per 1000	30.00	—	....
Magnesite, raw	ton	30 00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	90.00	—	....
Magnesia brick, Grecian, 9x4½x2½	net ton	140 00	—	....
Silica brick	per 1000	45.00	—	

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	....
Ferrochromium	lb.	Nominal		
Ferromanganese, domestic, delivered	ton	425.00	—	450 00
Ferromanganese, English	ton	200.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.25	—	....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	240.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	....
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.00	—	....
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The Alaska-Pacific Construction Company of Portland, Ore., has been incorporated with a capital of $300,000 for the purpose of constructing and operating steam, gas and sailing vessels. The incorporators are Charles A. Burckhardt, John H. Burgard and Lawrence A. McNary.

American Oil Developing and Leasing Corporation of Wilmington, Del., has been incorporated with a capital of $500,000.

American Oil Products Company of Wilmington, Del., has been incorporated with a capital of $500,000 to acquire lands and develop same.

The American Reduction & Chemical Company of Bellair, Ohio, has been incorporated with a capital of $50,000. The incorporators are J. A. Greenfield, A. C. Beetham, James W. Stewart, C. M. Wyrick and C. H. Dankworth.

Atlas Graphite Corporation of Birmingham, Ala., has been incorporated with a capital of $125,000. The incorporators are L. H. Weller, president; C. E. Massey, vice-president; John M. Hughes, secretary-treasurer.

Aurora Foundry Company, Seattle, Wash., has been incorporated with a capital of $10,000. The incorporators are John H. Ironside and Charles Budd.

A. W. Zinc & Lead Corporation has been incorporated in Delaware with a capital of $1,000,000 to conduct a general mining business. The incorporators are Harry McDaniel, Jr., L. B. Phillips, J. B. Bailey, Dover, Del.

The Beaver Chemical Company, Inc., of New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture chemicals, drugs, etc. The incorporators are H. and B. Lichtenberg, S. Fillin, 2013 Bryant Avenue, Bronx, N. Y.

Calumet Iron & Metal Company of Chicago, Ill., has been incorporated with a capital of $25,000. The incorporators are Samuel Goldberg, Henry Goldberg, Benjamin Friedman.

Cherokee Oil & Gas Company of Augusta, Me., has been incorporated with a capital of $1,000,000 to quarry, mine, melt, refine, prepare for market, etc., any metals, mineral substances, oil and gas.

Commonwealth Lead & Zinc Company has been incorporated in Delaware with a capital of $600,000 to acquire mining property and develop same. The incorporators are Arthur W. Britton, Louis H. Gunther, Harry B. Davis, New York City.

Connecticut Steel Corporation of Bridgeport, Conn., has been incorporated with a capital of $20,000 to carry on business of every kind of manufacturing of metal and metal articles. The incorporators are William S. Lane and Arnold W. Knauth of New York, and Cornelius C. Webster of Brooklyn, N. Y.

The Constatin Refining Company of Delaware has been incorporated with a capital of $5,000,000 to refine, store and market crude oil and by-products thereof. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del.; Clement M. Egner, Elkton, Md.

C. T. Products Corporation of New York City, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals and pharmaceutical preparations. The incorporators are J. A. Haggerty, C. C. Cooper, F. C. Peters, 120 Broadway.

Cuprite Sulphur Corporation of Delaware has been incorporated with a capital of $2,000,000 to carry on a general mining business, including that of gold, silver, sulphur, etc. The incorporators are Paul A. Zrezelman and William C. Griffith of New York, and Ernest H. Greenwood of Montclair, N. J.

Diament Oil & Gas Corporation of Buffalo, N. Y., has been incorporated with a capital of $75,000 to manufacture and deal in natural gas and petroleum products. The incorporators are R. E. Diament, J. H. Clark, M. E. Butler, all of Buffalo.

Dickerson Glue Joint Company of Grand Rapids, Mich., has been incorporated with a capital of $30,000. The incorporators are D. F. Hamilton, Glenn Dickerson and William English.

The Economy Fuel Company of Portland, Ore., has been incorporated with a capital of $20,000 to deal in real and personal property in Portland. The incorporators are Elizabeth Tipton, R. J. Streicher and Robert H. Down.

Frederick Iron & Steel Company, Frederick, Md., has been incorporated with a capital of $150,000 to manufacture, purchase, sell and otherwise deal in iron, steel, brass, copper and metals, etc. The incorporators are William A. Riddel, George M. Gittinger and Claude S. Hahn, all of Frederick.

Gilmore Manufacturing Company of New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture shoe black, ink dyes, chemicals, drugs. The incorporators are Benjamin Lifshitz, Robert Scherer, Morris Lippman.

Hightower Peanut Oil Mill of Brundidge, Ala., has been incorporated with a capital of $35,000 to manufacture peanut oil.

Inspiration Zinc & Lead Company of Wilmington, Del., has been incorporated with a capital of $250,000. The incorporators are M. L. Gatchell, L. A. Irwin, Harry W. Davis, of Wilmington.

Kansas-Utah Consolidated Oil Company of Wilmington, Del., has been incorporated with a capital of $3,000,000.

Kentucky Oil & Refining Co. of Wilmington, Del., has been incorporated with a capital of $1,000,000 to acquire oil lands and develop same.

Kinney-Brennan Petroleum Company has been incorporated in Delaware with a capital of $1,000,000 to produce and market petroleum, natural gas, coal and minerals. The incorporators are F. R. Hansell, Philadelphia, Pa.; J. V. Pimm and S. C. Seymour, Camden, N. J.

Lawrence Oil Corporation, New York, N. Y., has been incorporated with a capital of $2,000,000 to acquire oil lands and to develop the same. The incorporators are Arthur W. Britton, Louis H. Gunther, Harry B. Davis, all of New York.

The Linde Air Products Company has been authorized to manufacture oxygen, nitrogen and other gases in Oregon, with a capital of $200,000.

Linden Chemical Company of Linden, N. J., has been incorporated with a capital of $125,000 to manufacture and deal in chemicals. The incorporators are Adam J. Traub, Elizabeth; Norman W. Kempf and Louis A. Kempf, Newark.

Majestic Paint Company of St. Louis, Mo., has been incorporated with a capital of $10,000 to manufacture and deal in paints, oils, etc. The incorporators are S. E. Cowan, E. A. Koenemann and E. C. Breck, George L. Zollman and Chester Chapline.

Marine Steel Company of Wilmington, Del., has been incorporated with a capital of $250,000. The incorporators are M. L. Rogers, L. A. Irwin, Harry W. Davis of Wilmington.

The Metallograph Corp. of New York City, N. Y., has been incorporated with a capital of $540,000 to manufacture and refine brass, copper and other metals. The incorporators are I. M. Berliner, F. Spungin, J. J. Cohen, 135 West 115th St., New York.

Michigan Drop Forge Company of Delaware has been incorporated with a capital of $1,800,000 to manufacture iron and steel products. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del.; Clement M. Egner, Elkton, Md.

Milliff Refining Company, of Martinez, Cal., has been incorporated with a capital of $100,000 to operate a refinery.

National Aniline and Chemical Co., Inc., West Nyack, N. Y., has been incorporated with a capital of $17,231,000 to manufacture chemicals, coal tar products. The incorporators are I. F. Stone, W. Beckers, W. N. McIlravy, 17 Battery Place, New York.

Nitro-Phospho Corporation of Richmond, Va., has been incorporated with a capital of $500,000. The incorporators are M. C. Patterson, pres., T. S. Winston, v.-pres., John Landstreet, secretary-treas.

Ohio Mold and Foundry Company of Cincinnati, Ohio, has been incorporated with a capital of $50,000. Mr. C. B. Matthews, incorporator.

The Old Spanish Copper Co. has been incorporated in Delaware with a capital of $1,000,000 to produce oil and gas and acquire land containing the same. The incorporators are G. A. Lemmon, W. C. Darlington, H. Kolb, J. F. Ringle, J. H. Derieux, all of Strang, Okla.; L. Sier, Omaha, Nebr.

The Pacific Potato Starch Company has been organized with a capital stock of $60,000, to manufacture potato starch and by-products. Incorporators of the company are J. F. Griffith, Albert Muesig, and J. A. Turner. A plant will be erected.

Palladium Paint Company of Atlanta, Ga., has been incorporated with a capital of $25,000. The incorporators are N. T. Poole, A. W. Stirling, and F. A. Quillian.

J. F. Patton & Co. of Delaware has been incorporated with a capital of $100,000 to buy and sell pulp, paper, etc. Representative J. F. Patton, 83 West 42nd St.

Republic Graphite Company of Jasper, Ala., has been incorporated with a capital of $100,000. The incorporators are John H. Bankhead, Jr., H. E. McCormack, W. A. Clark and others.

Residuum Oil and Burner Company has been incorporated in Delaware with a capital of $1,000,000 to manufacture and sell devices to facilitate combustion of oils, fuels and particularly residuum oils. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del., Clement M. Egner, Elkton, Md.

Sapo Chemical Co. of Toledo, Ohio, has been incorporated with a capital of $50,000.

Shynoff Chemical Co., Inc., of New York City, N. Y., has been incorporated with a capital of $6,000 for chemical business. The incorporators are P. Glass, S. Sussman, M. I. Price, 271 Broadway, N. Y.

Southern Ferro Alloys Co. of Knoxville, Tenn., has been incorporated with a capital of $210,000 to manufacture ferro alloys. The incorporators are J. Harry Price, W. F. Black, Geo. C. Hager and others.

Steel Works Appliance Company of Pittsburgh, Pa., has been incorporated with a capital of $5,000. The incorporators are August Gums, Stephen Buchle, Pittsburgh; J. A. Whitehouse, Carrick, Pa.

The Tool Steel Corporation of Pittsburgh, Pa., has been incorporated with a capital of $600,000. The incorporators are Robert McKnight, F. M. Neeper, A. M. Neeper, Pittsburgh, Pa.

White-Burbank Paper Co., Inc., of New York City, N. Y., has been incorporated with a capital of $50,000 to manufacture paper and wood pulp. The incorporators are L. O. White, 146 Central Park West; C. I. Hamilton, 145 West 138th St., New York City; F. W. Burbank, 1916 Albemarle Road, Brooklyn.

Wonder Paper and Fabric Company, Wilmington, Del., has been incorporated with a capital of $2,100,000. The incorporators are Herbert E. Latter, Henry M. Robinson, Clement M. Enger, Wilmington, Del.

Zobel, Stern & Campbell, Inc., New York City, N. Y., has been incorporated with a capital of $20,000 to manufacture colors and dyestuffs. The incorporators are H. E. Zobel, G. M. Campbell, B. F. Meyer, 253 Ninth St., Brooklyn, N. Y.

Capital Increases

Western Utah Copper Company of Nevada has increased its capital from $50,000 to $2,500,000. The officers are Harold R. Smoot, president, and Edwin T. Jones, secretary.

The American Gas & Incinerator Company of Vancouver, Wash., has filed amended articles of incorporation, increasing its capital stock from $30,000 to $40,000. C. R. Talbot, vice-president.

The National Electrolytic Company, Canal Basin, Niagara Falls, N. Y., manufacturer of chemicals, has increased its capital from $620,000 to $1,150,000.

Construction and Operation

Alabama

BESSEMER.—The American Tar Product Company expects to build an addition to its plant at Woodward for the manufacture of naphthaline for the making of explosives. The plant is at present turning

out creosote and other coal tar products. The new by-product ovens of the Woodward Company will furnish the product for running the naphthaline plant.

Arkansas

CAMDEN.—The Camden Foundry Company has built a new and large fireproof building of concrete and iron to replace the building recently destroyed by fire.

FORT SMITH.—S. P. Hardin and associates of Clarksburg, W. Va., and Pittsburgh, Pa., will erect a glass making plant which will cost $250,000 and employ 250 men. Two cars of window and plate glass will be manufactured per day. They expect the capacity to be doubled in a year.

TEXARKANA. — The Commercial Acid Company has just completed its new plant to replace the one burned a few months ago. The new fireproof building is of brick, concrete and galvanized iron. This building is equipped with new machinery.

Colorado

DENVER.—The Denver Steel & Iron Works will operate the largest structural steel plant in the intermountain region. It was formerly the Lowith Brothers Iron Works Company, located at West Colfax Avenue and Larimer Street, and was purchased by the Monarch Engineering Works. It will be run under the above name. They expect to produce enough structural steel to supply the entire Western territory.

Delaware

WILMINGTON.—The New Castle Leather Company will build six new additions to its plant at Eleventh and Poplar Streets. Erection of two of the structures has been commenced.

WILMINGTON.—The Otto Gas Engine Company of Philadelphia has sold its land in South Wilmington to a syndicate of Philadelphia and New Jersey capitalists. A steel plant will be erected on this property. The property includes several hundred acres along the south side of the Christiana River.

Georgia

MARIETTA.—The Glover Machine Works will have shortly, in connection with their plant, a steel foundry and forge shop. They will install an electric furnace, steam hammers, sand blast machinery, grinders, sand mixing machinery, etc. The Glover Machine Works specializes on industrial locomotives.

Idaho

LEADORE.—The Sunset Mining Company, which has recently developed enormous deposits of ore at its properties, located at Leadore, Idaho, will construct a new mill in the near future. Shipments of ore running 15 to 20 per cent lead and 8 to 12 ounces per ton continue to come in regularly. Much development work is being done and it has now been definitely determined that the 500,000 tons of milling ore which has been blocked out can be mined and put into the mill at the rate of 60 cents per ton.

Illinois

NORTH CHICAGO.—The Sexton Oil Company has opened its new factory at North Chicago, which will have an output of 300,000 gal. of oil a week without double shifts. The company makes a patented motor oil.

Indiana

TERRE HAUTE.—The Grasselli Chemical plant is expected to be in operation July 1. The plant will make spelter exclusively for the manufacture of brass and galvanizing and is claimed to be the largest of its kind in the world.

Kansas

NEODESHA. — Improvements to the amount of $300,000 will be made in the plant of the Standard Oil Company of Kansas this summer to increase the capacity for the manufacture of gasoline. Twenty stills will be added, making a total of 112, which will make it one of the largest plants in the Middle West.

Maryland

BALTIMORE.—The Baltimore Tube Company will erect a new plant, 140 by 600 ft., for the manufacture of sheet brass and copper, which will cost between $500,000 and $600,000.

BALTIMORE. — The Penn-Mary Steel Company will build a new one-story concrete copper shop, about 60 x 120 ft.

Michigan

DETROIT.—Henry Ford intends to proceed with the erection of a large blast furnace plant just outside of Detroit.

Missouri

ST. LOUIS.—The Majestic Paint Company, recently organized with a capital of $10,000 has made extensive alterations on its building at 1103 Locust Street and 402 North Eleventh Street. The company is agent for the Ohio Paint & Varnish Company of Cleveland, Ohio.

Montana

BUTTE.—The Continental Oil Company plans the construction of a plant covering a block in Valley Addition. Work will be completed during the summer.

HAVRE.—Local men who are boosting the flax fiber mill expect to have the plant in operation in the near future. A building, 50 x 50 ft., will be built. Company has been incorporated under the name of The Flax Mills Company, by F. F. Bossout, James Holland, E. C. Sweitzer, W. C. McKelvey, E. C. Carruth and C. F. Morris, with capital stock of $100,000.

New Jersey

NEWARK. — The Harrison Chemical Company has purchased waterfront property; also several buildings which are to be remodeled for its needs. This property comprises six acres at Newark Transfer, with a 300-ft. frontage on the main channel of the Passaic River, extending back 900 ft. to the tracks of the Jersey Central Railroad. This property was held at $75,000 and adjoins the plants of the Sun Oil Company and the Butterworth-Judson Company.

NEWARK.—The Alcohol Products Company will spend $75,000 on a new manufacturing plant which is to be located at the foot of Blanchard Street. It will be composed of a refinery building of brick and reinforced concrete construction, with a boiler room, and an office and laboratory building.

New York

JAMAICA BAY, LONG ISLAND.—The Corrugated Fiber Mills, Inc., purchased 5 acres together with buildings, having 70,000 sq. ft. of space, at the head of Mill Basin, Jamaica Bay, for the manufacture of paper products.

JOHNSON CITY.—Endicott, Johnson & Company have ordered the material for a new fiber board mill. This building will be started about Aug. 1, and it is expected that it will be completed in the late fall. The building will be 370 ft. in length, 250 ft. of which will be one-story and the remaining 120 ft. two stories and basement. The new plant will manufacture fiber board.

LAUREL HILL.—The General Chemical Company filed plans recently with the Building Bureau in Long Island City for a steel laboratory, 48 by 33 ft., to be erected at Washington and Laurel Hill Avenues, Laurel Hill, adjoining the company's present buildings. The laboratory will cost $6,000.

WARREN.—The Warren Oil Company intends to buy 12 acres of land on which to construct a blending plant. Improvements approximating $50,000 will be placed upon the new property.

Ohio

YOUNGSTOWN.—The Youngstown Sheet & Tube Company will erect a new steel plant for the manufacture of 84-in. plates at a cost of $2,000,000.

Oklahoma

ENID.—A contract was signed between the Southwestern Oil Corporation and the Enid Refining Company for the construction of a pipeline from the oil fields east of Enid to Enid, and the building of another refinery.

Oregon

ASTORIA.—The Standard Oil Company here has purchased a block of land on the waterfront and will expend $150,000 in construction of a thoroughly fireproof plant. F. E. Roper, of Seattle, will direct installation of the plant.

MOLLALA.—The Mollala Fire Clay Company has started work on its clay mine near Mollala. A 100 ft. tunnel is being driven, and work on the kilns will begin shortly. The company holds the only clay deposit known on the Pacific coast which will make white stoneware pottery.

Pennsylvania

CARNEGIE.—The Superior Steel Company has purchased extensive property adjoining its works, for the erection of new additions.

CORNWALL.—The Bethlehem Steel Company is reported to be planning to double the capacity of its local iron ore properties, providing a total of 80,000 tons per month.

HARRISBURG.—The Keystone Industrial Corporation, recently incorporated with capital of $1,500,000 to manufacture boilers, engines, etc., is reported to be planning for the erection of its proposed plant at Middletown. George W. McIlhenny, 25 North Thirteenth Street, and D. A. Caley, 23 North Fourth Street, are the principal incorporators of the company.

PHILADELPHIA.—The Kali Manufacturing Company is enlarging its equipment in the plant at 1406 North Front Street by installing larger motors and new machinery. The company expects to increase its manufacture of oils for the textile trade.

PHILADELPHIA.—The Gill Glass Company acquired title to two tracts in the northeast section of Philadelphia on which it will erect a large factory building.

PHILADELPHIA.—The India Refining Company, manufacturer of oils, has filed plans for alterations and improvements in its plant at Swanson and McKeon Streets to cost $2,500.

PHILADELPHIA.—The Powers-Weightman-Rosengarten Company, Ridge Avenue and Calumet Street, is planning for the erection of a one and two-story brick addition to cost about $25,000 to replace the section of its plant recently destroyed by fire.

PHILADELPHIA.—The Nice Ball Bearing Company has awarded a contract for the erection of a one and three-story addition to its plant about 170 x 320 ft., at Twenty-ninth Street and Hunting Park Avenue, to cost $175,000. William Steele & Sons Company, contractors.

PHILADELPHIA.—Fire, June 2, destroyed part of the plant of the Barrett Manufacturing Company, Tucker and Bermuda Streets, with loss estimated at $40,000.

PHILADELPHIA. — The Philadelphia Paper Company is arranging for the immediate erection of its proposed new one-story plant, about 170 x 270 ft., at Manayunk.

PHILADELPHIA. — The Pierce-Arrow Tire & Rubber Manufacturing Company, Germantown, is having plans prepared for the erection of a new plant to cost about $150,000. J. Osborn Hunt, Trenton, N. J., is architect.

PHILADELPHIA. — The Westmoreland Chemical & Color Company has filed plans for the erection of an addition to its plant on Twenty-second Street.

PHILADELPHIA.—The American Pulley Company, 4200 Wisahickon Avenue, manufacturer of pulleys, hangers, etc., will build a one-story addition, about 50 x 70 ft.

READING.—The Reading Knob Works, Oakbrook, will build a new one-story foundry addition, about 50 x 50 ft.

WARREN.—The Warren Oil Company purchased 12 acres of land lying west of Warren upon which will be built a blending plant. Improvements approximating $50,000 will be placed on the property.

Tennessee

MOUNT PLEASANT.—The Hoover & Mason Phosphate Company is building a new plant about one and a half miles from Mount Pleasant on the Mount Pleasant Southern Railroad. It will cover five acres of a 650-acre tract which contains phosphate enough to engage employment for twenty-five years. It is being built entirely of steel construction.

NASHVILLE.—The Nashville Products Co. is a new manufacturing concern located at 912 Church Street, to manufacture floor cleaners and disinfectants. The promoters are I. W. King and Henry Foster of Nashville.

Utah

SALT LAKE CITY.—The Utah Paraffine Oil & Wax Co. will erect an oil shale distillation plant for the manufacture of crude oil, paraffine wax and ammonium sulphate. The company has been experimenting for three years and will use a distillation process similar to those used on oil shales in Scotland. Mr. Lawrence Greene of Salt Lake City is president and general manager of the company and Mr. O. W. Ewing is managing director. Research work has been conducted at the University of Utah and Detroit Testing Laboratories.

Virginia

NEWPORT NEWS.—The Empire Steel Company, recently incorporated, is planning for the purchase of a local site for the installation of a large steel works. The plant is estimated to cost about $900,000, and will include steel furnaces, billet mill and auxiliary structures. The local Chamber of Commerce (J. N. Shannahan, president), is interested in the project. Joel F. Armistead, Atlanta, Ga., is head of the company.

Washington

CHEWELAH.—The Northwest Magnesite Company has completed plans for proposed development of its magnesite claims. A large crushing mill will be installed immediately, an aerial tramway built, and six rotary kilns installed, with capacity of 600 to 1000 tons daily. A big plant, costing $200,000, will be started as plans are completed. R. S. Talbot heads the concern.

IRONDALE.—After an idleness of almost five years, the blast furnace of the defunct Western Steel Corporation at Irondale, Wash., about 50 miles from Seattle, is being placed in working condition by the Pacific Coast Steel Company of Seattle, who has acquired the property. Between $75,000 and $100,000 will be expended before the furnace is ready to blow in, and the work will require sixty days' time. Engines and machinery of the plant, which has been damaged by long idleness, will be overhauled, and new equipment added at many points. Practically the only existing structure will be replaced by new buildings, the big wharf will be rebuilt, and the ore and coke elevators overhauled. Present plant has capacity of 60 tons daily, which will not be increased at present. William Piggott, president of the Steel Company.

NORTHPORT.—The Northport Smelting & Refining Company is building and equipping a plant for the treatment of smelter gas, to cost in the neighborhood of $100,000. Structure will be 75 x 150 ft., and equipped with a series of 900 pipes, to which metallic particles will be attracted electrically while suspended in the fumes. The equipment is known as the Cottrell system, and is expected to save 5 per cent of the values, and pay for itself in six months of use.

SEATTLE.—The Linde Air Products Company, a New York concern, has leased a site at Eighth Avenue South, Seattle, on which a big plant will be erected. The main building will be one-story, 130 x 282 ft., of reinforced concrete and steel, costing $300,000.

SEATTLE.—The General Basic Products Company, located at 2926 Sixteenth Avenue S. W., although organized but two years, has a modern manufacturing plant, and has developed a splendid business, both local and foreign. The plant manufactures stone cement, stucco, fireproofing materials, sanitary wall finishes, calcimine, cold water paints and Puritan Lime. The company does a large export business.

SEATTLE.—The Puget Sound Cement & Lime Company, Seattle, according to V. C. Coxhead, has leased thirty-five acres of State land near Ballard, on which it plans to build a plant for the manufacture of cement and plaster and lime.

SEATTLE.—A series of experiments by the College of Mines, University of Washington, indicates that graphite from the Seward peninsula of Alaska can be refined for commercial use, according to Joseph Daniels, Assistant Professor of Mining. Samples of graphite have been refined by the concentration process.

SEATTLE.—The American Nitrogen Products Company, Securities Building, will start work at once on additions to its nitrogen plant at La Grande, which will make the plant three times its present size. The first unit, now in operation, cost $50,000.

SPOKANE.—Oliver P. Moore, secretary-treasurer of the Washington Steel & Iron Company, has invented and patented a new oil and gas burning smelter furnace. It is a combination, consisting of a pre-heating and reduction chamber and a smelting and refining chamber.

SPOKANE. Day Brothers, owners of the Hercules Mine, are making large additions to the Wallace Mill, including installation of four tube mills, 36 Franz tables and additional jigs. The improvements are to permit of remilling the tailings for the iron, to be used at the Northport smelter.

SPOKANE.—Washington State Pharmaceutical Association will convene in Spokane on June 14, 15, 16. A. W. Linton is secretary of the association.

SPOKANE.—The Spokane-Benton County Natural Gas Company has applied to the city council for a franchise to pipe natural gas into the city, build a distribution plant which will produce 2,000,000 cu. ft. of gas daily.

SPOKANE.—The Spokane Corrugated Culvert & Tank Company, of this city, plans to immediately double the size of its factory, and extend its lines of manufacture. C. A. Mowry is secretary-treasurer and general manager. Approximately $20,000 worth of new machinery will be installed, and an addition, 100 x 100 ft., together with an office building, will be constructed.

TACOMA.—E. D. Gallaher, general manager of the American Minerals Producing Company of Tacoma, is at the head of a syndicate which proposes to develop an extensive deposit of potassium nitrate and sodium nitrate near Vale, Ore. An experimental plant will be installed at the property, which is claimed by chemists to contain nitrate of high value and tremendous quantity.

TACOMA.—Frank S. Baker, local, who is at the head of a project to install a paper mill near Tacoma, states that details for the plant are complete, and construction will begin shortly. Plant, including buildings and machinery, will cost $400,000.

West Virginia

CLARKSBURG.—The Hope Natural Gas Company will erect a gas producer plant at Downs for experimental purposes. The capacity of the plant when completed will be equal to two ordinary gas wells. The product will be used to operate the big gas producing stations and what is not used will be turned into the gas mains to experiment with the natural product. The coal to run the producer will be supplied by the Rachel Coal Company.

KANAWHA CITY.—The Libbey-Owens Sheet Glass Company and the Owens Bottle Machine Company will be in operation shortly, making an investment of $5,000,000 and will be the largest sheet glass and bottle plants in the world. These plants cover a site of 76 acres, and will employ hundreds of men. C. W. McNulty & Company of Charleston and Huntington have the contract for the general construction work at the Libbey-Owens Sheet Glass plant, while the Toledo firm of Devore-McGormley Company, industrial engineers and architects, planned the several buildings which constitute the great plant. W. J. Monaghan of Toledo, is the supervisor of the construction for the architects. The main building is to be 504 ft. in length and 396 ft. in width. In the front portion of the building six tanks have been constructed, each 72 ft. long, 20 ft. wide and 5 ft. deep and each having a capacity of 170 tons where the molten glass is made. Mr. William Jacobs of Toledo will be the manager of the plant and Arthur E. Fowle general manager.

Wisconsin

MILWAUKEE.—The Wisconsin Metal Refining Company, Fratney and Franklin Streets are occupying their new factory which is 80 by 150 ft.

ST. FRANCIS.—The Valley Forge Company of Pittsburgh, is to build a $1,000,000 steel mill at St. Francis, in Milwaukee County. The mill will be about 100 x 300 ft. of light steel frame and wood sheathing.

Wyoming

COWLEY.—The Columbia Carbon Company of New York will erect a large plant for the manufacture of carbon black at Cowley, Wyo. The carbon black will be manufactured from natural gas drawn from the wells of the Wyoming Consolidated Oil Company. The first building of the unit will be 14 ft. by 114 ft. The first unit will have 96 buildings of this dimension, which will cost $600,000.

Manufacturers' Notes

CATALOGUES AND TRADE PAPERS WANTED IN CHILE.—Commercial Attaché William F. Montavon, at Lima, Peru, recently visited the library and reading room of the Sociedad de Fomento Fabril in Santiago, Chile, an organization with headquarters in Santiago, which has for its purpose the promotion of manufacturing in Chile. The Secretary of the Sociedad de Fomento Fabril is desirous of exchanging the bulletin of its association with trade and industrial journals in the United States. The Secretary would also appreciate receiving catalogues of American manufacturers and exporters, which will be placed on file in the library and reading room. The address of the society is: "Sociedad de Fomento Fabril, Casilla 4114, Santiago, Chile."

THE ROSS POWER EQUIPMENT CO. have been appointed Indianapolis representatives for The Lincoln Electric Company of Cleveland, Ohio, and their offices are at 617 Merchants Bank Bldg., Indianapolis, Ind.

RESOURCES OF BOLIVIA ON EXHIBITION.—The Consul General of Bolivia, in the United States, announces that he has now on exhibition, at the Consulate—forty-first floor of the Woolworth Building, New York City—a part of the minerals, rubber, precious woods and other native products of the Republic of Bolivia, that were shown at the late Panama-Pacific Exposition in San Francisco. He would be pleased to receive callers to view the specimens. This exhibit will be maintained at the Consulate as a permanent feature to aid in the dissemination of information regarding opportunities in Bolivia. All inquiries should be addressed to the Secretary.

LARGE HEATING AND VENTILATING INSTALLATION. — The National Acme Company of Cleveland, Ohio, has placed an order with the Buffalo Forge Company, Buffalo, N. Y., for a large heating and ventilating equipment. The equipment consists of four Carrier type "A" air washers with automatic control and fresh and return air dampers; four Niagara Conoidal supply fans, two of which deliver 100,000 cu. ft. of air per minute each, and two 95,000 cu. ft. of air per minute each; four exhaust fans, two of which will handle 70,000 cu. ft. of air each and two 50,000 cu. ft. of air per minute each; ten Baby Conoidal fans for toilets; twenty-seven thousand sq. ft. of Vento and four 12 x 14 steam engines for driving the fans. Geo. S. Rider & Co. are the consulting engineers.

PRODUCTION OF COPPER IN 1916.—An advanced official statement of the production of copper in the United States in 1916 has been issued by the Geological Survey. The author is B. S. Butler. The smelter production of primary copper was 1,928,000,000 pounds, compared with 1,388,000,000 pounds in 1915, an increase of 39 per cent. Arizona was the largest producer again with a record of 694,847,307 pounds. Montana was second with 352,139,768 pounds, and Michigan third with 269,794,531 pounds. Utah, Alaska, New Mexico and California follow in the order named. The total production of new refined copper in 1916 was 2,259,000,000 pounds, an increase of 625,000,000 pounds over 1915. The production of secondary copper was 104,423,807 pounds. In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively, produced a total of about 553,000,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 662,000,000 pounds from secondary sources. Of this total at least 250,000,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

There was also produced about 56,000,000 pounds of bluestone, averaging 23-25 per cent copper.

THE MANUFACTURE OF PHTHALIC ACID AND PHTHALIC ANHYDRIDE.—The Department of Agriculture announces that the Color Investigation Laboratory of the Bureau of Chemistry, of this Department, has perfected, on a laboratory scale, a new process for the manufacture of phthalic acid and phthalic anhydride. This process, as carried out in the laboratories, appears so promising that it is thought that some manufacture of chemicals and dyestuffs in this country may be able to supply their demands for these compounds by this process, provided the process can be reproduced upon a technical scale so as to obtain results commensurate with the laboratory investigations.

With a view to helping the chemical industry of this country, the Department of Agriculture hereby announces that it is ready to assist manufacturers who wish to produce these compounds. The expenses of the technical installation and of the labor and materials necessary will of necessity be borne by the firm, individual, or corporation who wishes to manufacture the products. The chemists of the Color Investigation Laboratory will assist with expert advice, etc. The Department reserves the right to publish all the data obtained from the technical experiments.

Since it seems very desirable that phthalic acid and phthalic anhydride be made available in large quantity in this country at the earliest possible moment, this offer of assistance will not be held open by the Department for an indefinite period.

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Regulation of Iron and Steel Prices

That it would eventually become necessary for the Government to regulate prices in the iron and steel industry has been apparent for some time. There is no reason to suppose that there is any serious opposition, in the minds of the steel producers, to a wise and efficient system of regulation. Certainly no such opposition has been expressed. Some articles have been published, written by novices, suggesting difficulties, and pointing out, for instance, that if the price of this commodity were regulated and the price of that commodity were not, an injustice would be done; suggesting further that the Government needs taxes, but how can there be taxes unless there is something to tax? Purposely or otherwise they overlooked the fact that there is no efficiency in robbing Peter to pay Paul and then taxing Paul. Better tax them both—collect the revenue at the source, so to speak.

It bespeaks a rather profound ignorance of the steel trade to argue that the products are so varied that an equitable schedule could not be drawn up or adhered to. What was the experience of 1908? In time of peace, with no inspiration greater than a desire for the common good; with no obligation more than a half-expressed moral one; in fear that what they did was not approved by the Government, rather than with knowledge that the Government insisted upon their doing it; with buyers only too eager to tempt them to infractions—the steel manufacturers then maintained with considerable success a price structure that was utterly contrary to the law of supply and demand. The real force at work at the time was merely the knowledge that if the market were broken all would suffer in their profits. The price structure was well understood in 1908, and it was adhered to with sufficient faithfulness to maintain the situation for more than a year.

It will be taken for granted that there can be no regulation of the price of one commodity without regulation of the price of another, or of a finished product and not of the raw or intermediate materials. A complete structure must be built up. Fair profits should be allowed, both for the economic benefit accruing and to make certain that production shall be at the maximum, for the reason that a figure which nets a profit to one mill may be ruinous to another, poorly positioned in this or that respect.

As to the relationship in prices, the experience of the past may be taken, checked by an examination into the extent to which costs have changed. The average relationship that has obtained between various commodities,

between bars and structural shapes, for instance, are well known. The differentials for size, shape, etc., in the different lines are well established. A schedule to proportion profits between the coke producer, the blast furnace and the steel maker should not be difficult. No such schedule, certainly, would produce the inequalities, indeed the iniquities, that have obtained in the recent past.

In April, 1916, there were $45 billets with $18.50 pig iron. Afterwards the price of billets doubled while the price of pig iron tripled. One or the other alignment was wrong. In July, 1916, there was $2.65 Connellsville coke and $18 pig iron. On June 30 of the present year there was $16 coke and $54 pig iron; triple-priced pig iron and sextuple-priced coke. Early in 1915 blue annealed sheets sold at $4 a ton more than plates, and 28-gage black sheets at $10 a ton more than blue annealed sheets, all of which was in keeping with the cost of manufacture. In May and June, 1916, plates and black sheets sold at the same price while blue annealed sheets sold at $2 a ton more. Since March, 1916, wire nails have sold at a lower price per pound than the wire rods from which they are made. The keg is thrown in.

The steel industry gracefully and cheerfully, even amusedly, having "put up" with these inequalities, has no great reason to be perturbed by prospects of inequalities growing out of price regulation by the Government.

As to profits in the aggregate, the prices now quoted as representing the market are so much higher than the prices at which material was delivered in the last period for which earnings statements of the steel companies are available, that there can be no comparison. Such market as exists is practically fictitious, but it is the only market that can be quoted, and on an average the prices are fully double those at which material was being shipped in the first quarter of the year. The earnings at that time were of course quite satisfactory, seeing that they were at record rate.

The essence of price regulation, as we understand it, is to see that the ordinary buyer of steel is not penalized because the Government becomes a buyer. There can be no competition between individual and Government, as the Government sets, or will set, its own prices, but the ordinary commercial buyers would bid against each other in the effort to secure steel, and the contest would be won by the man who could boost the price the highest.

This price, in turn, would be limited only by his ability to dispose of the metal, perhaps through a long chain of "intermediates," to the ultimate consumer. The Government would collect perhaps 20 per cent of the excess profits of the steel maker, and not a red cent from the consumer of steel. Doubtless the consumer would be glad to be able to limit his liability to the aforesaid 20 per cent tax. A far better and more patriotic policy is "one price to all," neither ruinous to the individual in the purchase of his necessities, nor exorbitant to the government, that is to say, the American people, in this time of need.

Leather Substitutes

In the present issue is a short note by Andrew H. King on the making of substitutes for leather—especially as regards the manufacture of shoes. His pronouncement that, even at present, rubber soles are better than leather, and that a wholly non-leather shoe of equal utility appears to be not only a possibility, but an actuality, should be very good news to many a suffering pater familias, standing amazed at the combined efforts of his active youngsters and the no-less active shoe market. Mr. King's views in this may be taken as authoritative, inasmuch as readers of Metallurgical and Chemical Engineering will remember his recently published and masterly articles on various other phases of the rubber manufacturing industry.

The Internal Combustion Engine

To the many debts we owe the internal combustion engine—not the "interior combustible" engine, as one of the Washington correspondents recently had it—there is likely to be added, according to the military experts, the debt of its winning the war for us. The science of aviation has kept ahead of the engine that has brought the flying machine to its present stage of usefulness. At the outset, the Wright brothers were able to rise from the ground merely by giving their machine its initial acceleration by means of a weight. Going still farther back, an anecdote, now first appearing in print, may be told.

The laws of the air in relation to flight were investigated exhaustively by the late Dr. Samuel Pierpont Langley, then director of the Allegheny Observatory. The experiments, by the way, were financed largely by the late William Thaw, vice-president of the Pennsylvania Railroad Company. There are few, probably, who know that the laws governing aerial flight were given to the world through the grandfather of the Lieutenant Thaw who has won laurels in France by practising the art of which his forebear had dreamed.

But to the anecdote of the internal combustion engine: Dr. Langley's experiments were conducted chiefly by means of an "aerodrome," a horizontal structure mounted on a vertical axis. At one end of the structure various pieces of apparatus were mounted in turn, to be driven against still air, so as to record the various performances of planes and propellers. To drive the aerodrome or turntable there was provided a 5-hp. gas engine of standard make. One day it became desirable to resume the outdoor experiments, and the mechanician was instructed to start the gas engine. After a time he succeeded, and the turntable was driven at the magnificent speed of six revolutions per minute. That was not enough, and while the authorities consulted, a young assistant, still in his teens and with the surplus energy of the period, seized the handle that was provided for bringing the turntable to any desired position for adjustment purposes, and drove the turntable thirteen revolutions per minute, developing four times the power of the 5-hp. engine, if the resistance

increased as the square of the speed. An expert was then summoned, who spent half a day grinding the valves. Then the engine ran half a day and stalled. The expert wanted to spend another half-day regrinding the valves, but Dr. Langley called them all off and adopted a rusty old harvester engine that happened to be in the neighborhood.

That was the status of the internal combustion engine at the time the laws of flight were being developed. About eighteen years afterwards the Wright brothers flew. They acknowledged their debt to Langley for the laws governing flight, the world had given them the engine and they had invented their stabilizing and other devices which enabled one to fly without coming to grief. Gustav Lilienthal had had many successful "glides" without a motor before he met his death in one sixteen years before the Wright brothers flew.

Fixing Prices

Suppose we were engaged in raising potatoes. We suppose this because we have no desire to represent special interests in the matter, and we have also no intention to go into Potatocal Engineering. Let's imagine, then, that we are potato producers, and that collectively we grow spuds for the whole community. It is not a monopoly, we are rivals in business and yet potatoes are scarce. Labor is hard to obtain and wages are high. The community that supports us numbers, let us say, about fifteen thousand souls—or, rather, to keep the idea of our business in mind, fifteen thousand human stomachs. We are tenant farmers and the land all belongs to Uncle Hiram, who has stipulated in every lease that each tenant shall provide him, pro rata, with potatoes for the needs of his immediate family according to his requirement, and at his own price. We can afford to do that, especially as the old man is a bachelor and lives very simply. It is merely one of his foibles, and we count it as a negligible addition to the annual rent.

Sunday mornings after the long sermon and while the young folks are achieving merit in Sunday school, we walk around the churchyard, chew peppermint leaves and timothy stalks, and discuss potato prices. It is gossipped that one or two of the more speculative storekeepers have been bidding on the crops of certain neighbors before the harvest, and we listen with delight to the observation of some hired man who has heard tell—although he disremembers when or where—that prices for well-grown, mealy potatoes ought to reach four dollars and over a barrel by next fall. We are not accustomed to such figures; and yet, although we are not clear in our minds as to our costs, it sounds agreeable.

Then suppose something extraordinary, something utterly unexpected and undreamed of should happen: Uncle Hiram, if you please, has gone and turned Mormon; he has married a thousand wives, all of them widows, with an average of nine children each. To pile on the agony, the last, lamented husbands of Uncle Hiram's new soul mates were mostly Irish; and while you may be a little uncertain as to what an Irishman will do under given circumstances or what his politics are, there is never any question that he will endow his progeny with an appetite for potatoes. We also learn (as in a footnote) that Uncle Hiram's price for his family requirement of potatoes for 1917 is *fifty cents a barrel.*

Now we have a situation to meet that is new and bewildering to us farmers—although it may be growing familiar to the steel men, the coal producers and some others. Our crop of potatoes was a little short even for the fifteen thousand inhabitants of the community, but Uncle Hiram's addition of ten thousand more to it, and one-half of them Irish, puts us in a quandary. We do not know how many barrels of potatoes he will require, but we can guess and we can fear; and we do know the price. We cannot agree on selling values for the rest of our product because that is against the law; it would be a conspiracy in restraint of trade. Uncle Hiram, on the other hand, does not have to agree with anybody, or conspire, or do anything but make up his mind that he will pay fifty cents a barrel, and that fixes the price for him. His action is legal. So we become worried, sorely worried.

But still worse is the fix of our neighbors who are engaged in other walks of life. We have all the potatoes there are, none may be purchased elsewhere, and there are not enough to go around after Uncle Hiram's generous two-fifths have been extracted. We do not need to do anything to bring about high prices. Our neighbors bid against each other while we hold off to observe the fireworks. In the course of time the soaring prices may assuage our distress, but in that very measure there may arise trouble in the town. The incidence of competition would shift from sellers to buyers and in potatoes there would be at once a famine and a wild market, which is always an unwholesome situation.

We have no comment to make on Uncle Hiram's conversion. We desire to avoid all discussion of religion, and if his marriage to the thousand widows was an act of faith we have neither cause nor right to complain. But his price of fifty cents a barrel for his own many potatoes seems to us to work hardship upon the rest of the community. Not only are they shortened in their supply but they are called upon to pay unheard-of prices. They are crippled in their various walks of life. They are injured in business and in health and in the end they may be unable to pay rent as promptly as they did—if indeed they can pay it at all—and Uncle Hiram, who owns everything, needs rents now more than ever before.

It seems to us that it would have been better if the old gentleman had fixed his price at something nearer the market. Some of his wives might be thrifty, and feed thinner. Others might cook rice. And the community would not have to pay so much to us very much frightened farmers, who, being particularly anxious to cover our expenses lost in the deliveries to Uncle Hiram's step-flock, would err on the side of caution.

Readers' Views and Comments

Magnetic Separation of Tungsten Ores

To the Editor of Metallurgical & Chemical Engineering

Sir:—In your June 1 issue, page 632, mention is made under "Some Uses of Magnetic Separators," that magnetic separation is not used in the Netherland District of Colorado for the treatment of tungsten ore.

As the undersigned is perfectly familiar with conditions in that locality, he wishes to advise you that this is not literally true, as hundreds of tons of these tungsten concentrates and middlings are annually treated over the Wetherill magnetic separator. In some cases concentrates have been increased from 40 to 65 and 70 per cent tungstic acid, and where pyrite is associated with ferberite, magnetic separation is indispensable.

A large three-magnet separator of the Wetherill type is at present operating in Boulder.

During the last three or four months the writer has tested hundreds of tungsten ores magnetically and success was obtained on practically all of them. It was proven that the magnetic separation was a commercial success and in several instances the only salvation in saving the values.

In the garnetiferous scheelite ores of Nevada and California, difficulty of separating garnets from scheelite was encountered by wet concentrating methods. The trouble is obviated by the use of the Wetherill magnetic separators which have eliminated all of the garnets and raised the grade from 10 to 25 per cent. Considering the present high bonus for purity, magnetic separation speaks for itself.

Arthur C. Daman.

Denver, Col.

Guayule Rubber

To the Editor of Metallurgical & Chemical Engineering

Sir:—With reference to the article by Andrew H. King on "Guayule," in your issue of Nov. 15, 1916, and on "Rubber Planting," in your issue of Jan. 15, 1917, the following notes from my experiences may be of interest.

In November, 1904, I operated at Torreon, Mexico, the first plant extracting rubber from guayule by mechanical means, as per my U. S. patent No. 779,696, Jan. 10, 1905, Mexican patent No. 4079, Oct. 22, 1904. This was the birth of the guayule industry. Several smaller concerns, established later, paid royalties, but the more important ones infringed upon my patent rights.

Several years ago I visited the University of Arizona, at Tucson, and there saw an experiment in progress with growing about ½ acre Guayule. These plants were subjected to irrigation. I called their attention to the fact that most of the plants in sight were Mariola instead of Guayule, but I noticed several well and perfectly-formed guayule plants, and therefore came to the conclusion that Guayule can be grown successfully.

Over five years ago I prepared addresses on "Rubber Planting in the United States." I repeat what I then stated, that Guayule and Landolphia, "the creeper," having rubber in threads within the bark, can be grown in many sections of California, on lime formations, close to transportation, and purchasable at $2 to $4 per acre. I am informed that the Intercontinental Rubber Co. are planting an extensive tract with Guayule in Arizona. Excessive heat, drought, or cold is not detrimental to Guayule. It is a winter plant, and the International Rubber Co. is following a sound pursuit. There are ways to plant from the seed at a nominal cost; the advantage of planting shoots is that it results in a year's saving in the time necessary before it becomes of sufficient size for use.

Latex-holding Florubanda, a creeper holding a fair quality of rubber, and Chitte trees, such as are abundant on the west coast of Mexico, producing rubber, can be sown in California. There also exist in Utah or Idaho "Indian Roots," and in California a "Rattlesnake shrub," which grows abundantly, 4 to 10 ft. high, and contains 3 to 4 per cent rubber.

There never need be a scarcity of good quality hard rubber in the United States, as such can be produced to perfection by pulverizing any rubber-containing shrub, adding thereto sulphur (or in some instances litharge) and vulcanizing the mass. I hold patents on this process, but owing to the cheap compounds being used at present the advantages I offer are meager.

F. Ephraim.

San Francisco, Cal.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

Western Metallurgical Field

Molybdenum

According to an article by E. P. Grant, in the Bulletin of the Canadian Institute, June, 1917, the International Molybdenite Co. treated 2350 tons of ore containing approximately 60,000 lb. of MoS_2 at their various plants. The ores were shipped from properties in Ontario, Quebec, and British Columbia, about half of the total tonnage treated being custom ores, while the rest came from the company's own properties. The ores from the different localities are dissimilar in character, some containing iron sulphides in large amounts and some being very micaceous. The ores from British Columbia seem to be freer from deleterious substances than those from Ontario and Quebec, although the flakes of molybdenite are very much smaller, and in some instances are nearly amorphous.

The ores are treated at the concentrator at Renfrew, which was completed in September, 1916, by a process developed after eighteen months' experimentation. On entering, the ore goes to a jaw crusher, thence to a

gyratory crusher, and thence either to storage bins or to a rotary drier. The flow up to this point is effected by gravity. The material is then raised to the top of the mill, where it is delivered to a large set of rolls and screens, the undersize dropping on a conveyor belt leading to storage bins in the flotation department. The oversize is raised by a bucket elevator to a second set of rolls and screens, the undersize again being sent to the storage bins in the flotation department. With ores containing large flakes of molybdenite a fairly good concentrate may be obtained by proper screening practice. As a rule, this concentrate is taken to sampling rolls to be cleaned, while the undersize goes to the flotation department. An automatic sampler is placed immediately below the gyratory crusher, and the bulk sample thus produced is reduced to an assay sample in the usual manner.

The flotation department adjoins the mill, and is housed in a building 90 ft. long by 30 ft. wide. It contains nine flotation machines, 6 ft. wide by 18 ft. long. The chutes from the storage bins mentioned above are 12 ft. above the floor level, and discharge into a traveling hopper of 1200 lb. capacity, and which in turn discharges into 2400-lb. hoppers feeding the flotation machines. The material discharges from the feed hoppers through adjustable openings to the feed boards of the flotation machines. The flotation machines have a capacity varying from 500 to 1500 lb. per hour, depending upon the character of the material treated, the finer the material the lower the capacity. The size of material floated also varies with the nature of the ore. Usually, a product through 20 mesh gives satisfactory results, but it has been found necessary at times to crush some ores through a 60-mesh screen. The concentrate is collected at the end of the machine, dried on steam driers, and is then ready for shipment; or, if low grade, is given a special treatment. The tailing is carried to the dump by means of waste water.

It has been demonstrated that it is most economical to produce a product ranging between 60 per cent and 70 per cent MoS_2, and this is therefore the company's aim. The mill was designed to handle 100 tons of ore per day but at present its capacity is from 50 to 60 tons. The following table gives an idea of the percentage extraction. The tonnage put through was small and the extraction a little above normal.

Day	Lb. Floated	Per Cent MoS_2 in Heads	Per Cent MoS_2 in Tails	Per Cent Recovery
Oct. 17	23,400	2.29	0.24	90
	22,200	1.16	0.17	90
Oct. 18	15,000	1.64	0.16	90
	19,800	1.66	0.21	87
Oct. 19	28,800	1.35	0.26	80
	28,800	1.71	0.49	71
Oct. 20	28,200	1.74	0.24	86
	20,400	1.37	0.31	80

The concentrate from the mill is shipped to the company's refinery at Orillia, which produces ferro-molybdenum, molybdic acid, and ammonium molybdate of both commercially and chemically pure quality. The first stage of the process is to convert the concentrate into crude ammonium molybdate. This is then charged into an electric furnace with the requisite amount of iron. The furnace department has a capacity of two tons of ferro-molybdenum per 24 hours. The furnace product contains 70 per cent to 76 per cent metallic molybdenum, less than 0.1 per cent sulphur, no phosphorus, no copper and about 3 per cent carbon. All the ferro-molybdenum produced at present is sold to the Imperial Munitions Board.

The chemical department produces molybdic acid (85 per cent and 99 per cent), and ammonium molybdate. At present only the chemically pure materials are made. Some research work has been done in this department in connection with producing molybdenum dyes and molybdenum wire. The chemically pure molybdic acid and ammonium molybdate are supplied for laboratory purposes to Canada and the United States.

The company produced ferro-molybdenum, molybdic acid and ammonium molybdate valued at $110,000 in the year ending on Dec. 31, 1916. However, these figures are not representative of actual operations as ferro-molybdenum has only been produced since October, 1916. At present the production will amount to $500,000 per annum, and is increasing rapidly. These statements are of interest, as this concern is unique as being one which mines and purchases molybdenum ores, operates its own concentrator, uses its own process of concentration, refines all the products from its concentrator, and at the same time produces chemically pure reagents.

Labor Troubles

The whole Rocky Mountain district seems to be having an epidemic of strikes. None of these concern a very large body of men, but rather are local infections of rather limited extent. The operations of all allied industries, however, may be seriously curtailed by the strike of a few electricians or engineers. On the other hand, internal dissensions among the unionists over jurisdictional or other rights are a prolific cause of trouble. In their entirety it seems probable that a large decrease in metal production will result.

The Colorado Mill Operators' Association

A new society of the above name has been organized, and held its first regular meeting on June 30, at the Brown Palace Hotel, Denver, Col., presided over by the president, Judge E. A. Colburn. The society was organized with the hope that other States might follow the lead, also forming such associations, all of them interested in milling practice, which will then unite, becoming a strong and efficient national organization, which, as a whole, will be capable to consider matters of national import in the field of milling. Mr. G. L. Nye, H. C. Colburn and J. M. McClave presented interesting papers on flotation, while J. M. Hyde discussed informally the recent decision in the suit of the Minerals Separation Limited vs. Hyde. Mr. J. F. Collbreath, secretary of the American Mining Congress, also spoke on the work of his organization.

Recent Development in the Missouri, Kansas and Oklahoma Zinc Fields

The most noteworthy developments are the strikes made in the Miami field. Quite a few mills in the Webb City and Carterville districts are now being dismantled and are being shipped into the Kansas and Oklahoma fields. The price of blende at present being $75.00 for the highest grade, ranging down to $60.00 for second and third grades, makes it rather hard for the producers in the Webb City and Carterville fields to produce blends profitably. This is also true of some of the South Joplin Mines, since the average cost of mining and milling in these dis-

tricts is from $68.00 to $75.00 per ton of blende. However, there are quite a few mills operating in the older fields, some are fairly profitable and some are merely hanging on, but the operations are gradually being reduced to the better producers.

The ores in the Miami district, while very rich, are not quite so freely liberated as the ores in the Joplin fields, requiring a finer grinding.

The adoption of table concentration in preference to the old-fashioned sand jig, is very noticeable in the entire district, while flotation is gradually but surely coming. Several small installations are floating their ores and several larger mills are under construction. The flotation concentrates, however, are causing difficulties, particularly those from the Miami field, where the lead in the original ore is often quite high. As is commonly the case with most complex ores and particularly with ores from the Joplin district, lead is concentrated in the finer sizes. For this reason the flotation concentrate may contain from 10 to 20 per cent lead with a zinc content of 40 to 45 per cent, which naturally requires a subsequent separation of lead and zinc. Of course the smelters do not favor an extremely fine concentrate, and as a whole, this particular type of product will require some new metallurgical treatment.

One concern in Webb City is now conducting extensive research work on the manufacture of zinc dust, and has produced some dust showing a precipitating efficiency of 75 per cent working on silver cyanide solutions. This might open a welcome outlet for some of the flotation concentrate which at present is otherwise not very desirable.

Flotation

Although only a few years old, the flotation process has risen to be the main system for concentrating ores. According to Prof. Francis A. Thomson the flotation plants of America are handling 30,000,000 tons of ore each year, while the world's capacity is 50,000,000 tons. Flotation leads all other methods of treatment in America, as is shown in the following table:

Method	Tons Per Year
Flotation	30,000,000
Copper smelting	26,000,000
Gravity concentration	25,000,000
Gold and silver milling	13,000,000
Lead smelting	5,500,000
Copper leaching	2,000,000
Zinc smelting	1,000,000

Approximately the same ratios apply to the world production, except that the proportion treated by copper smelters will be less and by gold mills greater than here given. It would be easier to enumerate ores which are *not* being floated than to list the other category. Gold, silver, copper, lead, zinc, molybdenum, cinnabar, tungsten and many other ores are being successfully handled, and it is proposed to use the process for the recovery of substances as far apart as flour-gold and anthracite coal. It looks as if there may be keen competition between cyanidation and flotation in the treatment of gold and silver ores during the next few years, with the odds apparently in favor of cyanide for gold and of flotation for silver.

It is only natural that a process which has arisen to such eminence in the short space of six years should excite universal interest among miners, millmen and metallurgists, not to mention the legal profession. The very evident ease and economy with which it makes very difficult separations commends it to the practical mill man, while its unexplained modus operandi irresistably attracts the scientific metallurgist to its mysteries.

Unfortunately, the progress of the flotation process has been marred by unending litigation between the owners of a number of the basic patents and various concentrating mills who have either wittingly or unwittingly committed infringements. It is notorious that a very large percentage of mill operators have assumed an openly hostile attitude toward the Minerals Separation Company which is unfortunate in the extreme, but which they aver is entirely due to "bulldozing" and other "armstrong" methods of the holding company. It is a matter of universal regret that it seems impossible to suppress recrimination leading even to actual war during the development of this process, which has such wonderful potentialities.

Company Reports

1916 Report of Camp Bird Limited.—During the year 26,237 tons (wet weight) of ore were treated at the stamp mill and at the cyaniding plant. This tonnage yielded $791,749.55, an average of $30.92 per ton, as compared with $29.47 for last year. The running-time in both mills was 331 days, 1 hour, 50 minutes, based on a maximum of 25 stamps dropping for 24 hours per day until the 11th of May, and beginning May 12th a maximum of 20 stamps dropping 8 hours per day until the 24th of June, when 20 stamps started dropping 24 hours. There was a saving of 97.13 per cent of the gold in the crude ore, and a saving of 95.19 per cent in the combined value of gold and silver. Of the total value extracted, 63.88 per cent was extracted by amalgamation, 31.63 per cent by concentration and 4.49 per cent by cyanidation.

Annual Report of the Utah Copper Company for 1916.—The total quantity of ore milled at the Magna Plant was 6,143,500 tons, being an increase of 910,200 tons as compared with 1915. At the Arthur Plant 4,850,000 tons of ore were milled.

The average grade of ore treated at both plants was 1.435 per cent copper as compared with 1.434 per cent copper for 1915. The average recovery at both mills was 62.34 per cent, corresponding to 17.90 pounds of copper per ton of ore, as compared with 64.13 per cent, or 18.39 pounds of copper per ton for the previous year. The low extraction is mainly due to the large tonnage of ore treated, and in small part to the presence of unrecoverable carbonates.

The cost of milling at the Magna Plant was 35.35 cents per ton and at the Arthur Plant 40.94 cents per ton as compared with 30.91 cents and 39.02 cents, respectively for the year 1915. The average cost of milling at both plants was 37.82 cents per ton as compared with 34.02 cents for 1915. The increased cost was due to higher costs of labor and supplies. In fact, the cost per ton should have been considerably lower than the cost for the previous year on account of the greater tonnage treated.

The total gross production of copper contained in concentrates was 196,752,631 pounds, and the average grade of concentrates was 18.71 per cent copper. The corresponding figures for 1915 were: Copper in con-

centrates, 156,207,376 pounds; concentrates contained 19.17 per cent copper. The copper contained in direct smelting ores amounted to 664,849 pounds. The value of gold and silver recovered from the copper amounted to 0.653 cents per pound of copper treated.

During the course of the year the feeders and conveyors in the coarse crushing department of the Magna Plant were remodelled. The feeders in the fine crushing department of the same plant were also changed. At the Arthur Plant, the electric sub-station was remodelled, some new equipment for the foundry was purchased and the main tunnel for tailings and concentrate launders was enlarged. Near the end of the second quarter, designs were sufficiently advanced to start construction upon the additional equipment for the purpose of improving recoveries, and increasing the capacity of the mills. Three of the thirteen sections of the Arthur Plant were practically remodeled before the end of the year but were not put in operation, due to unavoidable delays in the receipt of some parts of the equipment. Similar improvements will be continued at this plant and started at the Magna Plant. The improvements consist principally in adding to the fine grinding and concentrating equipment. When completed it is expected that the combined capacity of the plants will be 40,000 tons per day, of which the Arthur Plant will handle 16,000 tons and the Magna Plant 24,000 tons.

Construction work on a new leaching plant was started early in August, 1916. It is contemplated to construct 12 concrete leaching tanks. The twelve tanks will have a capacity of from 3000 to 4000 tons per day. The plant is so situated and planned that its capacity can readily be increased to 10,000 tons daily. The material to be treated at this plant consists of the oxidized and partially oxidized capping overlying the sulphide ore bodies. It is estimated that 40,000,000 tons of this material will be available for treatment. The copper content of this oxidized ore body is estimated at 13 pounds per ton of ore. Experiments indicate that about 10 pounds of the copper content is soluble in dilute sulphuric acid. Results of tests show that approximately 9 pounds of copper can be recovered from one ton of capping. The net cost of treatment will amount to about 9 cents per pound of copper recovered.

The Engineering Council

On June 27 the first meeting of the Engineering Council was held. This body is a department of the United Engineering Society and has recently come into being as a medium of co-operation between four national engineering societies. The function of the Council may perhaps best be described by the following extract from the by-laws of the United Engineering Society: "The Council may speak authoritatively for all member societies on all public questions of a common interest or concern to engineers."

The Council is composed of twenty-four members, five being appointed by each of the four founder societies and four by the United Engineering Society. Its present membership follows:

American Society of Civil Engineers.—J. F. Stevens, (Chas. Warren Hunt), George F. Swain, F. H. Newell, Alex. C. Humphreys, F. D. Galloway.

American Institute of Mining Engineers.—P. N. Moore, S. J. Jennings, B. B. Lawrence, J. Parke Channing, Edwin Ludlow.

American Society of Mechanical Engineers.—I. N. Hollis, Chas. Whiting Baker, John H. Barr, A. M. Greene, Jr., D. S. Jacobus.

American Institute of Electrical Engineers.—H. W. Buck, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

United Engineering Society.—Clemens Herschel, B. B. Thayer, I. E. Moultrop, Calvert Townley.

At the organization meeting held in the rooms of the American Society of Mechanical Engineers on June 27 the following officers were elected:

President, I. N. Hollis; Vice-Presidents, H. W. Buck, George F. Swain; Secretary, Calvert Townley; Executive Committee, the four officers named with J. Parke Channing and D. S. Jacobus.

The council discussed at length ways and means by which the founder societies through the Council may be of use to the nation. The unanimous desire to help the Government in the prosecution of this war resulted in a resolution instructing the executive committee to co-operate with the government in procuring the services of engineers, also the appointment of a committee of three consisting of Messrs. H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby, to consider the best means of utilizing the inventive ability of members of the founder societies.

The secretary was instructed to inform all Government Bureaus that might be interested in the organization of the Engineering Council and its desire to be of assistance.

St. Louis Meeting of the American Institute of Mining Engineers

Oklahoma Oil Fields

Those attending the annual meeting of the American Institute of Mining Engineers will be interested in viewing, among other things, the enormous development

VIEW OF GLENN POOL FIELD NEAR NEW TANEKA, SAID TO BE THE WORLD'S LARGEST OIL FIELD

of the oil resources of Oklahoma. The magnitude of the operations springing up almost over night may be realized by the accompanying view in the Glenn Pool Field.

Work of the Council of National Defense

The first official comprehensive statement of the organization and accomplishments of the Council of National Defense and its Advisory Commission was incorporated in a report from the Director of the Council and Advisory Commission, Mr. W. S. Gifford, to the chairman of the Council, Secretary of War Baker. The length of the report (48 typewritten pages) is indicative of the enormous amount of work accomplished. The great value of the accomplishments to date can be gathered from the introductory statement giving a brief summary of the work as follows:

The mobilization of the 262,000 miles of railroads of the country for the Government's defense.

The close-knit organization of the telephone and telegraph companies of America to insure to the Government the most rapid and efficient wire communications.

The settlement of the recent threatened national railroad strikes.

The very general acceptance by labor and capital of the suggestion of the Council that existing labor standards should not be changed until the need for such action had been determined by the Council with the steadying influence on industry growing out of such action.

The procurement of 45,000,000 lb. of copper for the uses of the Army and Navy of the United States at less than one-half of the then current market price—a saving to the Government of approximately $10,000,000.

Similar accomplishments as to steel, zinc and aluminum.

The completion of the inventory, for military purposes, of 27,000 American manufacturing plants.

The money saving to the Government, through appointment over the country of committees of business men to assist the quartermasters' department of the Army in the economical and efficient purchase of supplies.

The saving to the Government of millions of dollars by the proper co-ordination of purchases through the agency of the General Munitions Board of the Council of National Defense.

The creation, under the medical section of the Council, of a General Medical Board, consisting of many of the most highly qualified surgeons and physicians of the country.

The selection by the same section of thousands of doctors specifically qualified for membership in the medical officers reserve corps, and the standardization, far on its way to completion, of surgical instruments and supplies.

The creation by the Council of the Aircraft Production Board, which is setting out to make 3500 airplanes and to train 8000 aviators this year.

The very definite results obtained by the Council's Committee on Coal Production in the procurement and expeditious shipment of coal, both in the civilian and federal interests.

The successful initiation of a movement to co-ordinate activities on the part of the States of the Union for the national defense, brought to a clear and workable focus by the conference of States held recently in Washington at the call and under the auspices of the Council.

The organization of a railroad committee to send to Russia; and

The enlistment of reserve engineer regiments to aid in rehabilitating the railroads of France.

A list of the members of the Council and its Advisory Commission, and of the various sub-committees, was given in our issue of June 1, 1917, page 633.

General Munitions Board.—On April 9, 1917, the General Munitions Board began its work under orders of the Council. The chairman of this board is Frank A. Scott, vice-president of the Warner & Swasey Co. The board has co-ordinated the department buying of the Army and Navy in order to avoid competition in the various departments. It has made investigations and recommendations and drawn up contract forms in the purchase and manufacture of small arms, artillery, gun forgings, gun carriages, shells, cotton duck, raw materials, etc. It has also advised on cantonment work, optical glass for military instruments and gages. It has made adjustments with the British Government and compiled statistics of manufacturers. It has saved the Government considerable money through the co-ordination of purchasing.

Munitions Standards Board.—This board was created on March 20, 1917, by the Council.

Careful investigations have been made and meetings held with manufacturers of shells, machine guns, etc., with resulting introduction of modifications in specifications and design to permit of greater quantity of production. A comprehensive list of manufacturing concerns who had been and were manufacturing munitions for the Allies was compiled for confidential use and the productive capacity of the country along these lines was developed and tabulated.

Aircraft Production Board.—This board was organized to advise on design, specifications, standardization and production of aircraft and to co-operate with the Army and Navy in furthering the science of aviation. The board has worked on training plans, has assisted in starting schools, has adjusted the patent situation, investigated production facilities, developed plans for making training planes and battle planes and considerable other work. It is pushing the production of aeroplanes as fast as possible.

Inventions (Naval Consulting Board of the United States).—The Naval Consulting Board of the United States, headed by Thomas A. Edison and composed of eminent scientists and inventors, acts as a board of inventions for the Council of National Defense. The board is now, and has been for some time, actively engaged in the investigations of plans to counteract the submarine menace.

Commercial Economy Board.—The duties of this board, under the chairmanship of A. W. Shaw, are to ascertain how commercial business may best meet demands made upon it by the war, and how men, supplies and equipments now employed in trade can be made available for the needs of the Government without impairing the essential services of trade and without unnecessary hardships to the public at large.

The board is investigating retail delivery service, economies in trade and manufacturing, such as wrapping, packing, the effect of diversion of certain raw materials to the production of military supplies, etc.

Committee on Coal Production.—This committee, recently formed, has been active in strike difficulties,

transportation problems and Government and domestic supplies.

National Research Council.—At the request of the Council of National Defense the National Research Council is maintaining in Washington an active committee under the direction of Dr. George E. Hale and Dr. R. A. Millikan for the purpose of co-operating with the Council of National Defense in matters pertaining to scientific research for the national defense. The chairman of the Chemistry Committee of the Council is Dr. M. T. Bogert, who also has his office in Washington.

The National Research Council is at present engaged in such investigations as the study of devices for detecting completely submerged submarines and mines; range finders of various types; devices for detecting invisible aircraft and sapping parties; improvements in wireless apparatus and other instruments used with aircraft; military photography, prevention of corrosion and electrolytic action on the hulls of vessels; balloon fabrics; fabrics for army slickers; new explosives; and utilization of wastes and by-products. The committee on nitrate supply appointed at the request of the Secretary of War to consider the process to be used by the Government in its plant for producing nitrates for explosives and fertilizers, has submitted a full report. Through the co-operation of the Bureau of Standards and the geophysical laboratory of the Carnegie Institute with glass manufacturers, the problem of supplying the optical glass for military purposes is well advanced toward solution. Another vital matter which is being fully investigated is the study of noxious gases and methods of protection. Committees of or associated with the Advisory Commission, viz.: Committees on Transportation and Communication, Telephone and Telegraph, Supplies, Raw Materials, Minerals and Metals, Labor, Munitions and Manufacturing, Engineering and Education are all doing noteworthy work. The details of some of this will be given in a later issue. Lack of space prevents its publication here.

American Society for Testing Materials

Annual Meeting at Atlantic City, June 26-30, 1917

Undoubtedly the most important paper presented at the meetings of the American Society for Testing Materials, of which the first day's proceedings were reported in our preceding issue (this volume, page 11)—was that by Dr. **Charles W. Burrows** of the United States Bureau of Standards. He had been working for some time to determine whether there was a relationship between some easily-determined magnetic or electrical property of the metal with its homogeneity or constancy of physical properties. He now says that "the fundamental fact that there is a definite relation between the magnetic and mechanical properties of steel is so well established that the successful application of magnetic analysis to commercial testing is assured." He admits that apparatus for the particular case must be developed and operators trained, but "the difficulties presented are not excessive."

It is planned to publish this paper in a subsequent issue, and further comment is reserved until that time.

A subcommittee prepared tentative specifications which may be regarded as useful suggestions to metallurgists and microscopists in general, on proper **metallographic practice.** Their recommendations for this work are as follows:

The standard magnifications for making micrographs of steel and ferrous materials should be: 50, 100, 250 and 500 times, and for non-ferrous metals should be 25, 75, 150 and 250 times.

For general use in society reports and for showing the grain size of ferrous materials use a magnification of 100 diameters, and of copper and copper alloys, 75 diameters. Reproductions of micrographs in publications should be made of the exact standard magnifications. If micrographs submitted for publication are not, they should be enlarged or reduced to the nearest standard size, and should be printed in the form of squares in order to conserve space. With each micrograph should be printed an explanatory title, together with actual magnification, etching medium, treatment, etc., indicating what the author intends to show, so that it will not be necessary to search the text for general information.

Magnifications	Lens	Ocular
20 to 50	Microplaner or microtessar	None
30 to 70	32 mm.	Huyghenian ocular x5
75 to 150	16 mm.	Huyghenian ocular x5
250 to 500	Apochromatic 4 mm.	Projection ocular

All objectives should be corrected for uncovered objects, and the bellows extension regulated to give the exact magnification desired. It should be borne in mind, however, that increasing the magnification by increasing the length of the camera bellows adds nothing to the detail of the micrograph. This depends entirely upon the resolving power of the objective used.

Important suggestions as to the determination of grain size are as follows:

(*a*) *Alloys consisting of but one type of crystals* (*e. g.*, copper, alpha brass, etc.): In counting individual grains the original crystal, including the twinned layers, should be called one grain.

(*b*) *Alloys consisting of two metallographic components* (*e. g.*, steels, Muntz metal, etc.): The original grain which has given rise to the aggregation of the two components should be taken as the unit when determinable, and the individual component in other cases. When grain size is included in actual specifications, the term should always be defined.

For measuring grain size, two methods are recommended, depending upon the condition of the material:

(*a*) *For material in which the grains are equi-axed* (*e. g.*, most metals in the cast and in the annealed state): The planimetric method as modified by Jeffries is recommended for use as being very accurate and rapid. It is recommended that the circular area used should always include at least 50 grains.

(*b*) *When the grains are not equi-axed* (*e. g.*, in strained materials): Heyn's intercept method should be used, the average grain size being determined by counting the number of grains at a given magnification along a line of known length on two axes at right angles to each other, one axis being parallel to the direction of rolling. In some cases a third count along a line perpendicular to the other two may be desirable. This will necessitate the preparation of another polished surface.

The grain size as determined by the plani metric method should be expressed as the number of grains

per unit area (square inch or square centimeter). This may also, but less preferably, be expressed as the average grain area; or the average linear dimension of the grain may be given. The grain size as determined by the intercept method should be expressed by giving the average number of grains per linear unit in the two directions; or the average number per unit area together with the ratio of length to breadth of grain (L/B) may be given.

If grain size is to be included in specifications, it should be expressed as the maximum or minimum allowable as determined above. It is recommended that only in extreme cases should grain size be made the sole basis of rejection of material.

In the discussion of the report, it was pointed out by **George F. Comstock,** Titanium Alloy Mfg. Co., Niagara Falls, N. Y., that there should be separate standards for ferrous and non-ferrous metals and emphasized that 75 diameters, though possibly applicable to *rolled* nonferrous material, was not satisfactory for *cast* nonferrous material. Objection to the scale of magnifications recommended was made on the basis that the scales obtainable with many commercial pieces of apparatus, modified to suit the proposed standard of 50, 100, 250 or 500, would in some cases result in loss of definition or in others unnecessarily limit the field photographed.

The ever present question of **corrosion** was again up for consideration. During the discussion, Mr. **R. B. Carnahan,** Jr., second vice-president American Rolling Mill Co., Middletown, Ohio, deplored the lack of a real measure of corrosion. A metal roof is removed because of a few leaky holes, though many parts of it show no corrosion at all. To describe corrosion in terms of a loss of weight in an accelerated test is fallacious. The failure of a steel plate in spots may be due, he held, to flaws resulting from steel cast in a dirty or moist mold, from some malpractice in the soaking pit, from seams produced in rolling; and many of these mill influences may be worse than chemical shortcomings.

Mr. **W. R. Webster** submitted a short illustrated paper showing the lack of connection between interior surface defects on brass condenser tubes and corrosion therein. It is the belief of some engineers that defects on the interior surfaces of brass condenser tubes act to accelerate corrosion and that accordingly their presence even to a small degree should not be tolerated. Extended observation on the part of the author has failed to furnish a basis for such a belief. It has been found that tubes containing such interior defects are no more subject to corrosion than those which were free from them.

It has further been observed that there is no tendency whatever for areas of corrosion to localize in the vicinity of such defects. Moreover, many cases have been found in which severe pitting had occurred in the vicinity of such defects, but absolutely no tendency of the corroded areas to follow along the lines of defect has ever been noticed.

A recent case of severe corrosion was observed which furnishes very strong evidence that no such connection exists. The tubes had been in service in the condenser of a large stationary plant for about six months and then removed because of perforations caused by local corrosion on their interior surfaces. Of a lot of eleven tubes, eight were found to be absolutely free from surface defects in the vicinity of the corroded areas.

Particular attention was called to the fact that even where a corroded area crosses a defect, no tendency whatever for the corrosion to follow the defect is observable. In most of the samples the corroded area was confined to a distance not over 4 in. from the inlet end of the tube, the remainder of the tube being as free therefrom as when first made.

H. A. Gardner, assistant director of the Institute of Industrial Research, read a paper describing a series of exposure tests which were made on paints applied to large-size metal plates, 24 by 36 in., with the object of determining what grade of pigment is best suited for use as a priming coat.

After three years' exposure, the panels to which had been applied a single coat of red lead containing a substantial percentage of litharge were in better condition than the panels painted with a single coat of highly oxidized red leads or iron-oxide paints. Those portions of the panels to which had been applied two coats of paint, gave substantially the same relative results.

The paints used were reserved, examined and analyzed after storage for three years. The highly oxidized red leads in general were not in superior condition to the others, except in one instance where a red lead of low specific gravity was used. The other paints were soft and in excellent condition.

Much has been said regarding the hardening of red lead in packages, especially if the red lead should contain any pronounced percentage of litharge. It is interesting to record the condition of the paints used in these tests after standing for three years in half-gallon cans. When the cans were opened, some of the clear oil was removed from each package and ashed to determine the amount of pigment that had gone into solution. The results of the tests indicate that red leads high in lead tetroxide are quite as soluble in linseed oil as red leads high in lead monoxide.

The results obtained in the storage tests indicate that some chemical action takes place other than that to be accounted for by the formation of lead linoleate, since the latter is soft rather than hard. The writer is of the opinion that the chemical reactions which are partly responsible for the hardening of red-lead paints, cause the formation of lead glycerinate, a substance that is recognized as one of the hardest and most durable cementing materials. It is obvious, therefore, that linseed oil having a high acid number and often containing a substantial amount of free glycerin is dangerous to use in making red-lead paints that are to remain in packages for a long period previous to use.

Noteworthy papers which might also be mentioned were "A Method for Studying the Effects of Temperature Upon the Physical Condition of Asphalts, Waxes, Etc.," by **J. A. Capp** and **F. A. Hull;** "Determination of Absolute Viscosity by the Saybolt Universal and Engler Viscosimeters," by **Winslow H. Herschel;** "Light Versus Heavy Reductions in Cold-Working Brass," by **W. Reuben Webster.**

The Committee C-8 on "Refractories" presented a very interesting report on the testing of refractory materials under load at high temperatures, and on testing the slagging action of refractories. **C. E. Nesbitt** and **M. L. Bell** presented a paper on "Some Suggested Improvements in the Manufacture of Silica Brick," all of which we hope to publish in extenso in a following issue.

The Action of Aluminium Chloride on Pure Aromatic Hydrocarbons[1]

By Robert J. Moore and Gustav Egloff

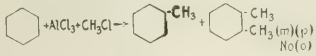
Contributon from the Havemeyer Chemical Laboratory, Columbia University, No. 298.

In a general study of the formation of benzene and toluene resulting from the action of temperature and pressure upon paraffin,[2] naphthene[3] and aromatic[4] base oils, it seemed desirable to work out the action of aluminium chloride upon pure aromatic compounds with a view to determining the yields of benzene and toluene, this information then to be applied to commercial sources which would contain in large quantity the aromatics studied. The aromatics studied for this preliminary information with respect to the course of reaction were benzene, toluene, xylenes, cumene and cymene.

A review of the literature indicated a number of reaction products resulting from the action of aluminium chloride upon pure aromatic hydrocarbons, but there was no report of the percentage yields of benzene and toluene resulting. The following communication covers the percentage yields of benzene and toluene resulting from the action of aluminium chloride upon the aromatics studied, benzene, toluene, xylene, cumene and cymene.

HISTORICAL REVIEW OF THE LITERATURE

It is well known that the action of methylchloride and aluminium chloride upon benzene builds up higher methyl derivatives of benzene. Ador and Rilliet[5] by passing methylchloride in the presence of benzene and aluminium chloride showed that the reaction took place as follows:



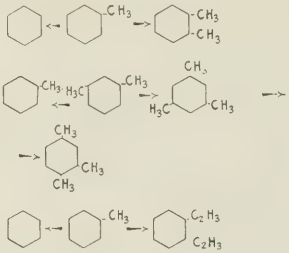
Jacobsen[6] a few years later carried the methylation of benzene much further in the presence of aluminium chloride. He was able to replace each hydrogen atom of the benzene ring by a methyl group clear to hexamethylbenzene. He found the course of reaction to be as follows:

benzene → toluene → xylene (o) (m) (p) { mesitylene / pseudocumene } → { durene / isodurene }

→ pentamethylbenzene → hexamethylbenzene

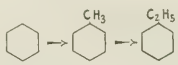
If reversibility of the reaction is assumed, the splitting off of alkyl groups from a benzene nucleus and the building up of higher homologs of benzene should be readily accomplished. But the decomposition products resulting from the action of aluminium chloride upon benzene and its alkyl derivatives are much more complex than such as would result from the simple transposition of alkyl radicals, for polycyclic compounds have been isolated which could have been formed only by the rupture of the benzene ring with the formation of pentacyclic substances of the picene type.

Anschütz and Immerdorff[7] gave in 1884 a note upon the course of reaction when toluene, (m) xylene and ethylbenzene were treated with aluminium chloride as follows:

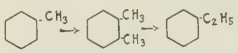


The mechanism of the reaction is explained by assuming a simple migration of the alkyl radical from one phenyl group to another. Friedel and Crafts[8] upon heating naphthalene and aluminium chloride from 100 deg. C. to 160 deg. C. found that benzene, hydronaphthalenes, and hydrogenated isodinaphthyl were formed in the reaction.

Upon testing further the effect of aluminium chloride on benzene[9] and toluene at a temperature between 180 deg. and 200 deg. C. they concluded that the reaction took place in the direction of:

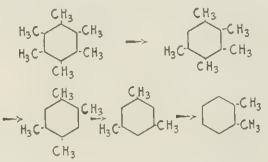


They noted that ethylbenzene resulted from toluene, which fact was not observed by Anschütz and Immerdorff.



In contradiction to Anschütz and Immerdorff, Friedel and Crafts stated that the reaction is much more complex than a simple migration of alkyl groups.

No theoretical discussion of the course of the reaction was attempted by either group of investigators. In treating hexamethylbenzene with aluminium chloride Friedel and Crafts[10] gave the reaction direction as:



They made the important observation that a gas was given off during the reaction of greater molecular weight than either methane or ethane and which was not absorbable in bromine, indicating paraffin formation. No exhaustive study has as yet been made as to the composition of the gases resulting from the action of aluminium chloride upon aromatic hydrocarbons.

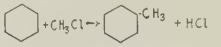
At the boiling point temperature little action took place between the reagent and benzene, but upon increasing the temperature to 180 and 200 deg. C. in a sealed tube the principal resulting products were found to be toluene, ethylbenzene and diphenyl. Toluene

[1]Presented before the Organic Section at the Spring meeting of the American Chemical Society, Kansas City, Mo., 1917.
[2]Egloff and Twomey, Jour. Phys. Chem., 20, 121, 1916.
[3]Egloff, Twomey and Moore, Met. and Chem. Eng., 15, 387, 1916.
[4]Rittman and Egloff, Met. and Chem. Eng., 14, 70, 1915. Egloff and Moore, Jour. Ind. and Eng. Chem., 8 (1917).
[5]Berichte 11, 1627, 1878 and 12, 329, 1879.
[6]Berichte 14, 2624, 1881.
[7]Ibid. 17, 2816, 1884.
[8]Bull. Soc. Chim. 39, 195, 1883.
[9]Loc. Cit. 42, 196, 1885.
[10]Berichte 15, 1451, 1882. Journ. Chem. Soc. 41, 115, 1882. Compt. rend, 100, 692, 1885.

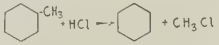
heated under similar conditions gave as products xylene, ethylbenzene and perhaps ditolyl. From the ultimate analysis and the boiling point, ditolyl seemed to have been formed. They were also able to isolate phenols which were probably formed from the oxygen of the air in the system, acting upon the aromatics in the presence of the aluminium chloride.

Jacobsen[11] in 1885 built up durene from mesitylene by the Friedel and Crafts' reaction. He asked the question, "Is it either a splitting off of a methyl group from the hydrocarbon, which unites with the mesitylene and forms (m) xylene, and perhaps first pseudocumene and then durene? Or are penta and hexa methylbenzene first built and then methyl groups splitting off, giving durene?"

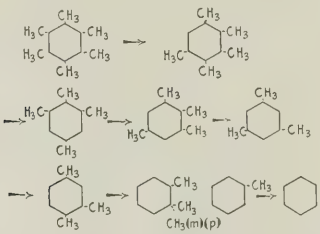
The well-known synthetic reaction of benzene and methyl chloride in the presence of aluminium chloride gives:



from which he reasoned that the reverse should be possible:



He treated hexamethylbenzene with one-half its weight of aluminium chloride at a temperature between 190 deg. and 200 deg. C. From analysis of the reaction liquid he recovered in large part:



Likewise carrying the tests with pentamethylbenzene, pseudocumene, mesitylene and (m)xylene the course of the methylation or migration of the methyl radical took place as follows:

hexamethylbenzene ← PENTAMETHYLBENZENE → durene / isodurene

pentamethylbenzene ← durene / isodurene ← PSEUDOCUMENE → xylene → toluene → benzene

durene / isodurene ← pseudocumene ← MESITYLENE → xylene → toluene → benzene

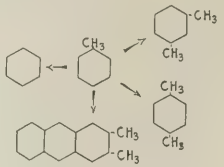
durene ← pseudocumene ← METAXYLENE → toluene → benzene

In all the reactions carried on by Jacobsen methylchloride was formed and he argued that the higher homologs of benzene resulted from the transposition of the methyl group.

A comprehensive investigation was carried out by Anschütz[12] in 1885 as to the action of aluminium chloride upon aromatic hydrocarbons. He selected for his investigation toluene, (m)xylene, pseudocumene, ethylbenzene and cymene. He heated toluene for three hours in a sealed tube with 30 per cent of aluminium chloride. The reaction liquid was fractionated and the distillate boiling between 79 deg. and 85 deg. C. gave a specific gravity of 0.8805 at 20 deg. C.

[11]Berichte 18, 338, 1885.
[12]Annalen 235, 179, 1886.

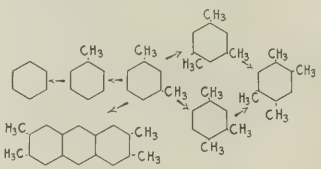
This fraction was nitrated and the benzene identified as dinitrobenzene; (m) and (p) xylene were isolated from the cut 135 to 144 deg. C. *No* (o)xylene was isolated and he concluded that it was not formed. A hydrocarbon solid was isolated which by Jacobsen's[13] method analyzed as dimethylanthracene. The course of the reaction from toluene was as follows:



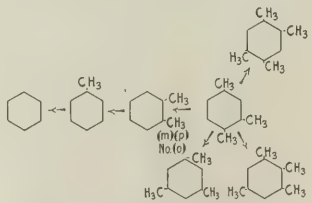
Metaxylene was heated with 25 to 30 per cent of aluminium chloride. The benzene formed was isolated in the cut from 80 deg. to 90 deg. C. and identified as the dinitrobenzene. The toluene was nitrated from the cut of 110 deg. to 114 deg. C. and isolated as trinitrotoluene. The 135 to 144 deg. C. fraction yielded metaxylene as the trinitro product with a melting point of 175 deg. C. and the para as the oxidized paratoluic acid and then to the terephthallic methyl ester. Mesitylene was analyzed by the Fittig and Wackenroder[14] method as the trinitromesitylene with a m.p. of 232 deg. C. The pseudocumene was isolated as the trinitroproduct with a m.p. of 185 deg. C. by a method devised by Jacobsen.[15]

Durene was isolated and identified by a method devised by Ador and Riliet.[16] There was isolated from the residue a hydrocarbon which seemed to be tetramethylanthracene with a m.p. of 290 deg. C.

The products isolated from metaxylene probably took the following course:



Pseudocumene gave the following compounds when treated with aluminium chloride: toluene, meta and paraxylene, mesitylene, durene and isodurene.

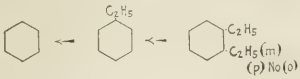


They stated that a syrupy mass of liquid remained in the flask as a residue and probably contained anthracene compounds, but was not investigated further.

Ethylbenzene reacted similarly to metaxylene in forming *no* ortho diethyl compound of benzene. Toluene

[13]Berichte 10. 1009. Ibid 11, 17.
[14]Annalen 151, 93, 295.
[15]Annalen 184, 179.
[16]Berichte 12, 331.

formed *no* ortho product of xylene. This seems to indicate that there may be some protective action of aluminium chloride in shielding the ortho position.



A residue was left in the flask which was a heavy black mass and was not investigated further.

Heating cymene with aluminium chloride gave a violent reaction and upon analysis of the reaction liquid gave mainly toluene. This would indicate that a splitting off of an isopropyl group resulted and not a migration over to another phenyl group, to form di or tri isopropyl derivatives of benzene. It seems likely that the reaction became exothermic and carried the reaction beyond the stability of the isopropyl compounds. Carrying out the reaction at a low temperature would yield entirely different results as to the migration theory of the Friedel and Crafts reaction.

Heise and Töhl[17] by passing hydrogen chloride through a solution of aluminium chloride and isopropylbenzene found that an isopropyl group would migrate to another phenyl radical. They found that the reaction products were propane, benzene, meta and paradiispropylbenzene. It is significant that they report the specific paraffin hydrocarbon PROPANE to be a product of the reaction. The formation of PROPANE reported by Heise and Töhl has led the authors to review the data of Rittman, Byron and Egloff[18] upon the "Thermal Reactions of Aromatic Hydrocarbons in the Vapor Phase." The analytical results are given in distillation cuts and specific gravity of cymene, xylene and toluene fractions which have been subjected to varying temperature and pressure conditions. A scrutiny of the specific gravity of the benzene cut to 100 deg. C. shows a set of values ranging from 0.855 to 0.883 at 15.5 deg. C.

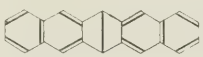
It is well known that the specific gravity of hydrocarbons is an additive property, and hence any value less than the specific gravity of pure benzene at 15.5 deg. of 0.883 must be due to a hydrocarbon or group of hydrocarbons with a specific gravity of less than 0.883 to bring it down to 0.855 at 15.5 deg. C. The lowering cannot be due to toluene, which has a specific gravity of 0.871 at 15.5 deg. C., hence in the *thermolization and pressurizing of aromatic hydrocarbons some paraffins or naphthenes must have been formed.* To what extent paraffins or naphthenes are formed requires further experimentation. In the present investigation of the action of aluminium chloride upon aromatic hydrocarbons the formation of hexahydrotoluene has been noted and will receive attention shortly.

Heise and Töhl treated ethyl, propyl[19] and butyl benzene with hydrogen chloride and aluminium chloride.

The products of the reaction for ethylbenzene were benzene, diethylbenzene (m) (p) and triethylbenzene. Propylbenzene gave as reaction products benzene, (m) (p) diproplybenzene upon six hours' heating with hydrogen chloride and aluminium chloride.

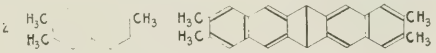
Under similar treatment butylbenzene gave benzene, (m) (p) dibutylbenzene, (O), (m) and (p) xylene, pseudocumene and mesitylene. It is to be noted that they report orthoxylene which Ador and Riliet and also Anschütz failed to isolate in their reactions.

Homer[20] in 1907, upon heating naphthalene in the presence of aluminium chloride for a period of time ranging from thirty minutes to six hours, found a tar formation which upon analysis gave three distinctly new compounds with the empiric formulæ of $C_{14}H_{10}$, $C_{26}H_{22}$ and $C_{40}H_{28}$. She was unable to isolate the reaction products reported by Friedel and Crafts[21] of hydronaphthalene and hydronaphthyl. From a pale yellow oil, the fraction boiling between 215 deg. and 225 deg. C./10mm. gave a substance of the formula $C_{14}H_{16}$, which in all probability was either tetramethylnaphthalene or diethylnaphthalene. From a later absorption spectra[22] study of the compound it was found evidently to check up with 1, 4, 5, 8 tetramethylnaphthalene. From the fraction boiling above 300 deg. C./10mm. a red transparent resinous highly fluorescent solid was isolated having an empiric formula of $C_{26}H_{22}$. It was suggested that it might be a homolog of dinaphthanthracene $C_{22}H_{14}$, with a formula as shown by Russig.[23]



From absorption[24] values $C_{40}H_{28}$ has a constitution similar to ββ dinaphthyl, and therefore is probably tetranaphthyl. The empiric formula of $C_{26}H_{22}$ exhibits an absorption curve similar to picene, and hence is very likely an alkyl derivative of picene.

The course of the reaction as Homer indicates it follows: naphthalene → ββ dinaphthyl → tetramethyl or diethylnaphthalene → $C_{26}H_{22}$ homolog of dinaphthanthracene or alkyl derivative of picene $C_{40}H_{28}$ tetranaphythyl. The probable equation would be:

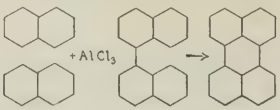


Heating for "hours" a mixture of benzene, aluminium chloride and hydrogen chloride in a sealed tube Gustavson[25] recovered an oil with boiling point range to 360 deg. C. and a resinous mass. He isolated a compound with a boiling point of from 230 deg. to 232 deg. C. identical in properties with 3-phenyl-1-methyl cyclopentane, as given by Borsche and Menz.[26] Another compound was isolated with properties the same as those given by Kursanoff,[27] which analyzed diphenylcyclohexane. The toluene observed by Friedel and Crafts, according to Gustavson, was formed most likely by the passing of a methyl group upon methylcyclopentane by transposition to cyclohexane and then dehydrogenation of the methylcyclohexane. The compounds isolated by Gustavson from the reaction upon benzene were 3-phenyl-1-methylcyclopentane and diphenylcyclohexane.

Scholl, Seer and Weitzenbock[28] in 1910 isolated the compound perylen from the action of aluminium chloride on naphthalene by refluxing at 180 deg. C. for one

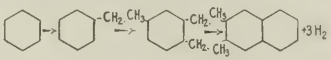
[17]Annalen 270, 155; Berichte 24, 768.
[18]Journ. Ind. and Eng. Chem. 7, 1019, 1915.
[19]Berichte 24, 768.
[20]Jour. Chem. Soc. 91, 1103, 1907.
[21]Comp. rend. 100, 692, 1885.
[22]Jour. Chem. Soc. 93, 1327, 1908.
[23]Jour. Prakt. Chem. 62, 30, 1900.
[24]Ibid.
[25]Compt. rend. 146, 640, 1908. Jour. Russ. Phys. Chem. Soc. 10, 390, 1878.
[26]Berichte 41, 190, 1910.
[27]Annalen 318, 309, 1901.
[28]Berichte 43, 2202, 1910.

hour. The course of the reaction as assumed by them, naphthalene to dinaphthyl to perylen as follows:



Homer[29] refluxing benzene ten to fourteen days with aluminium chloride at 100 deg. C. isolated naphthalene as one of the products which had been overlooked by Friedel and Crafts,[30] if it formed at all, under the conditions of their experiment. She isolated similarly to Friedel and Crafts—toluene, xylene, ethylbenzene, diphenyl and phenol.

An assumed explanation of the formation of naphthalene from benzene is given:



Contrary to the findings of Friedel and Crafts, phenol was isolated only in the lower cuts. The following formula weights were determined for the distillation products, and further work is going on to determine their constitution.

Distillation Temperature 10 mm. pressure	Molecular Weight
212 deg. C.	170
240	210
260	240
300	270

Summarizing the products reported by the various investigators upon the action of aluminium chloride and aromatic hydrocarbons, the following schematic outline is given which covers the actual compounds isolated under definite conditions of temperature and concentration. It must be recognized that the concentration of aluminium chloride, the time factor and temperature influence greatly the products resulting, and that no one reaction yielded all the products indicated, but that groups were isolated under definite conditions.

- Benzene
  - Toluene
  - Ethylbenzene
  - Diphenyl
  - Diphenyl-cylcohexane
  - 3-phenyl-1-methylcyclopentane
  - Naphthalene
  - Phenols
- Toluene
  - Benzene
  - Xylene (m) (p) *no* (o)
  - Ethylbenzene
  - Ditolyl (?)
  - Dimethylanthracene
  - Phenols
- Xylene (m)
  - Benzene
  - Toluene
  - Mesitylene
  - Pseudocumene
  - Durene
  - Tetramethylanthracene (?)
  - Phenols
- Mesitylene
  - Benzene
  - Toluene
  - Xylene
  - Pseudocumene
  - Durene
  - Isodurene
- Pseudocumene
  - Benzene
  - Toluene
  - Xylene (o) (m) *no* (p)
  - Mesitylene
  - Durene
  - Isodurene
  - Pentamethylbenzene
- Pentamethylbenzene
  - Durene
  - Isodurene
  - Hexamethylbenzene
- Hexamethylbenzene
  - Benzene
  - Toluene
  - Xylene
  - Mesitylene
  - Pseudocumene
  - Durene
  - Isodurene
  - Pentamethylbenzene
- Ethylbenzene
  - Benzene
  - Diethylbenzene (p) (m) *no* (o)
  - Triethylbenzene
- Propylbenzene
  - Benzene
  - Dipropylbenzene
- Isopropylbenzene
  - Propane
  - Benzene
  - Diisopropylbenzene
- Butylbenzene
  - Benzene
  - Dibutylbenzene (m) (p)
  - Xylene (o) (m) (p)
  - Mesitylene
  - Pseudocumene
- Cymene
  - Benzene
  - Toluene
- Naphthalene
  - Benzene
  - Hydronaphthalenes
  - Hydrogenated isodinaphthyl
  - Perylen
  - Alkyl derivatives of Picene ($C_{26}H_{14}$)
  - Tetranaphthyl ($C_{40}H_{26}$) (?)
  - 1,4,5,8 tetramethylnaphthalene
  - $C_{14}H_{10}$

Experimental

The experimental method consisted of distilling 500 c.c. of the aromatic hydrocarbon to which was added 10 per cent by weight of anhydrous aluminium chloride in a 1000-c.c. flask attached to a Glinsky column and 24-in. Liebeg condenser. The temperature of distillation was maintained over a period of twenty-four hours below the boiling point temperature of the aromatic treated. An evolution was noted of hydrogen chloride in each case of distillation. The distillate was neutralized with a 10 per cent sodium hydroxide solution, washed and dried over calcium chloride. The residue in the flask was filtered free of aluminium chloride, aluminium chloride compounds of the aromatic hydrocarbon used

[29] Proc. Camb. Phil. Soc. 16, 65, 1911.
[30] Loc. cit.

and carbon. The filtered oil was neutralized, washed and dried over calcium chloride, and added to the first distillate. The hydrocarbon liquid was then distilled in a Glinsky column and analyzed for its benzene and toluene content.[21]

The benzene was identified as the dinitrocompound and the toluene as the trinitrotoluene. The phenol present was identified by its boiling point and melting point. No attempt was made to isolate the cresols and higher phenolic compounds. The hexahydrotoluene was isolated by taking 100 c.c. of the fraction from benzene and toluene and by repeated extraction with fuming sulphuric and centrifuging after each treatment, and treating the residue liquid.

As many as twenty extractions with fuming sulphuric and five with fuming nitric acid were necessary to finally obtaining a liquid which resisted the action of both fuming sulphuric and nitric acid at room temperature. This unattacked liquid was then neutralized with sodium hydroxide, washed and dried over fused calcium chloride. The specific gravity, refractive index, boiling point and molecular weight by means of the vapor density method were taken of the residue liquid and clearly indicated hexahydrotoluene.

MATERIALS USED

Benzene.—The benzene used was water-white, thiofen-free and gave a specific gravity of 0.883 at 15.5 deg. C. and colorless upon sulphuric acid treatment. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	79.5
99.5	80.5
Dry point	80.9

Toluene.—The toluene was water-white, clear color in the sulphuric acid layer. The specific gravity at 15.5 deg. C. 0.871. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	109.0
99.0	110.5
Dry point	110.8

Xylenes.—The xylenes were water-white in color and gave a very faint lemon color in the sulphuric acid layer. This was cleared up to an almost imperceptible tint upon repeated acid treatment. The specific gravity of the mixture at 15.5 deg. C. was 0.870. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	137.0
98.0	137 to 142
Dry point	143.2

Cumene.—The cumene used was water-white and slight lemon color on sulphuric acid treatment. The specific gravity of the sample at 15.5 deg. C. was 0.867. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	151.0
94.0	155.0
99.3	160.0
Dry point	161.4

Cymene.—The specific gravity of the cymene used in this experiment at 15.5 deg. C. gave a value of 0.865. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	173.0
98.0	175.2
Dry point	178.6

Experimental Data

A. BENZENE

The benzene after distillation over a period of twenty-four hours in the presence of 10 per cent by weight of aluminium chloride gave after neutralizing, washing and drying a percentage yield of 92 per cent of unchanged benzene, approximately 1 per cent of phenols and 6.8 per cent of tar. This is in accord with the findings of Friedel and Crafts, who found but little change in the benzene at its boiling point; but when they raised the temperature to 180 deg. and 200 deg. C. in a sealed tube considerable decomposition took place with toluene, ethylbenzene and diphenyl formation. Gustavson isolated 3-phenyl-1-methylcyclopentane and diphenylcyclohexane from the action of aluminium chloride upon benzene. Homer upon refluxing benzene from ten to fourteen days at 100 deg. C. found naphthalene resulting from the reaction.

The formation of naphthalene from benzene by the action of aluminium chloride is highly interesting. Zanetti and Egloff,[22] working with catalysts and varying temperatures in the gas phase upon benzene, were *unable* to isolate naphthalene, although every precaution was taken to find it in the reaction. They found the reaction took the following course:

$$\left.\begin{matrix}\text{Carbon}\\ \text{Hydrogen}\end{matrix}\right\} \leftarrow \text{Benzene} \rightharpoonup \text{Diphenyl} \rightarrow \left\{\begin{matrix}\text{Diphenyl benzenes}\\ \text{Condensation products}\\ \text{containing 3 or more benzene rings}\end{matrix}\right.$$

The action of aluminium chloride under the conditions of Friedel and Crafts, Gustavson and Homer's experiments upon benzene seem to be much more vigorous than temperature changes of Zanetti and Egloff's work. The benzene ring is disrupted entirely in forming naphthalene in the presence of aluminium chloride. The substances isolated from the action of aluminium chloride on benzene is tabulated as follows:

Benzene →
- Toluene
- Ethylbenzene
- Diphenyl
- Diphenylcyclohexane
- 3-phenyl-1-methylcyclopentane
- Naphthalene
- Phenols

B. TOLUENE

There resulted from the action of aluminium chloride upon toluene a yield of 15.0 per cent benzene and 3.5 per cent xylenes. Sixty per cent of the original toluene was recovered, and there were formed 1 per cent of phenols and 0.8 per cent of hexahydrotoluene.

The hexahydrotoluene was isolated by repeated treatment with fuming sulphuric and nitric acid upon the benzene fraction. After each treatment the mixture was centrifuged and the residue sulphonated. Toward the end of the sulphonation fuming nitric acid was used. The unsulphonated and unnitrated residue was then neutralized, washed and dried over fused calcium chloride.

The toluene used in the experiment was subjected to

[21] Rittman, Twomey and Egloff, Met. and Chem. Eng., 13, 682, 1915.

[22] Jour. Ind. Eng. Chem. 9, 350, 1917.

similar conditions in order to isolate any hexahydrotoluene which may have been present. The toluene source was a coal-tar oil and resulted from the thermal decomposition of coal, and it was thought that perhaps the hexahydrotoluene isolated from the reaction of aluminium chloride upon the toluene might have been present in the starting material. But not a trace of an unsulphonated or unnitratable residue was obtained. It is quite certain that the toluene used contained no hexahydrotoluene. The refractive index, specific gravity, boiling point and molecular weight of the residue, unsulphonated and unnitrated were taken.

The refractive index was taken by means of a Pulfrich refractometer; the specific gravity by means of a 1c.c. pycnometer; the boiling point by means of the Smith and Menzies[33] method for minute quantities of material and the molecular weight by the Victor Meyer vapor density method. The following table tabulates the data:

	Values for the Physical Constants Found Hexahydrotoluene	Values for the Physical Constants According to Beilstein
Refractive index	1.42775	1.41705 1.42430
Specific gravity	0.7648/15.5 deg. C.	0.778/0 deg. C. 0.7662/18.5 deg. C. 0.7641/20.0 deg. C.
Boiling point	97.2 deg. C.	98.0 deg. to 100 deg. C. 97.2 deg. to 98 deg. C.
Molecular weight Vapor density method	103	98

Gustavson argued that Friedel and Crafts' toluene from benzene formed via a methyl radical migrating from methylcyclopentane to hexahydrobenzene forming hexahydrotoluene and then by dehydrogenation to toluene. The evidence from the present paper indicates clearly the formation of hexahydrotoluene, a step which was pure speculation on the part of Gustavson. His explanation of toluene formation from benzene seems to have experimental verification, due to the actual isolation of hexahydrotoluene in the benzene fraction from the action of aluminium chloride upon toluene.

To the list of compounds isolated from the reaction products of aluminium chloride upon toluene, hexahydrotoluene must now be added:

Toluene:
- Benzene
- Hexahydrotoluene
- Xylene (m) (p) *no* (o)
- Ethylbenzene
- Ditolyl?
- Dimethylanthracene
- Phenols

C. XYLENE

Xylene is an excellent source of benzene and toluene by the action of aluminium chloride. The xylene upon treatment gave 19.0 per cent of toluene and 5.6 per cent of benzene, with a recovery of 30.0 per cent of starting material. Phenols and cresols were formed in appreciable amounts during the reaction. Hexahydrotoluene was isolated from the toluene fraction and gave the following constants, refractive index 1.41637, specific gravity of 0.7640 and a boiling point of 98.0 deg. C. and M. W. of 103. The starting material was subjected to the same treatment in regard to isolating the hexahydrotoluene but no trace was found in the original xylene.

The following list covers the compounds isolated from the action of aluminium chloride upon xylene:

(m) Xylene:
- Benzene
- Toluene
- Hexahydrotoluene
- Mesitylene
- Pseudocumene
- Durene
- Tetramethylanthracene?
- Phenols

D. CUMENE

Under the conditions of the experiment cumene formed 1.5 per cent of benzene; 2.7 of toluene and 26.5 per cent of xylene with 63.6 per cent of recovery for the starting material.

It would appear that there is a gradual splitting off of alkyl radicals, to the next lower homolog of benzene. Cumene does not appear to form benzene and toluene in yields sufficient to make it an important source for these two substances.

E. CYMENE

Cymene upon aluminium chloride treatment gave an excellent yield of toluene. The per cent of toluene upon the basis of cymene used was 14.3, with 0.8 per cent benzene and 7 per cent xylene formation.

The percentage of recovered material was 28.5 with 48.4 going to a jelly-like mass. Work upon this jelly-like mass is proceeding and will be reported upon in a future communication.

Tabulation of the Data

The data are expressed in percents of aromatic hydrocarbons upon the basis of aromatic hydrocarbon used in the reaction.

Hydrocarbon Used in the Reaction	Benzene	Toluene	Xylene	Cumene	Cymene
Per cent recovered of					
Benzene	92.0	15.0	5.6	1.5	0.8
Toluene	...	60.0	19.0	2.7	14.3
Xylene	...	3.5	30.0	26.5	7.0
Cumene	...	...	...	63.6	...
Cymene	...	...	...	...	28.5
Residue	6.8	20.0	43.0	4.4	48.4

Summary

1. A review of the literature dealing with the aluminium chloride reaction on aromatic hydrocarbons has been given together with conclusions as to the tendencies of the individual compounds under treatment.

2. A chart has been given of the specific compounds isolated from individual aromatics upon aluminium chloride treatment.

3. A naphthene overlooked by previous experimenters has been isolated from the reaction of aluminium chloride upon toluene and xylene and identified as hexahydrotoluene.

4. Quantitative recoveries, lacking in the literature for the hydrocarbons, benzene and toluene from the aluminium chloride reaction upon aromatics were determined as follows:

Benzene—slight change.

Toluene—15 per cent benzene, 3.5 per cent xylenes . . . .

Xylenes—5.6 per cent benzene, 19 per cent toluene . . . .

Cumene—1.5 per cent benzene, 2.7 per cent toluene, 26.5 per cent xylenes . . . .

Cymene—0.8 per cent benzene, 14.3 per cent toluene, 7 per cent xylenes . . . .

[33] Smith and Menzies, J. A. C. S. 32, 897, 1910.

The Influence of High Temperature Upon the Elastic and Tensile Properties of Wrought Iron

By Frank A. Epps and E. Olney Jones

Owing to the comparatively recent use of iron and steel in a stressed condition at temperatures considerably above the usual range, it was thought by the authors that an investigation in this field might prove of commercial and engineering value. An examination of the engineering texts and literature showed that little had been done along this line, and the values that had been obtained were only for ultimate tensile strength, percentage elongation and percentage reduction of area. At the outset, therefore, it was decided to obtain reliable data on the variation of the elastic limit, and to check, if possible, the results obtained, by our predecessors, on the other properties.

The commercial application of the test is well worth considering. It is now generally admitted that all design work should be based on the elastic property of the metal, rather than on its ultimate strength. For metals at ordinary temperature, the use of a proper factor of safety brings the stress for which the piece is designed well within the elastic limit. As the results following will show, at higher temperatures this design factor of safety will have to be modified greatly, or the work will have to be designed wholly on an elastic limit basis. Up to the present, it is believed that this has been taken care of by greatly increasing the factor of safety when temperature conditions are to be considerably above normal. If the factor of safety has not been increased on the basis of experimental data, it is possible that there are instances now in existence where the metal is under a stress exceeding its elastic powers.

A few specific applications of the subject are given herewith:

Temperatures of superheated steam vary from 450 to 550 deg. Fahr. The strength of tubes, valve stems, etc., as affected by these temperatures, is indeed worthy of serious consideration.

Average boiler temperatures range from 300 to 450 deg. Fahr., and even within this range it is possible that the elastic properties of the metal are changed.

Metal rigging above large crucibles or ladles carrying molten iron is exposed to a heat far more intense than would be supposed. The failure of any part of such a system might result in a great loss to property and life.

Gas engine and gas turbine design is largely complicated by the temperature to which the metals may be safely subjected.

Blacksmiths have learned from the school of experience that iron should not be worked below a red heat. While it is not the purpose of this investigation to reach the temperature of a workable red heat (1500 deg. Fahr.), it will be shown that at least it is very inadvisable to work iron below temperatures of 1000 deg. Fahr.

In outline, the four main features to be considered are:

1. The metal to be tested.
2. The method of heating the specimens.
3. The method of measuring temperature.
4. The method of measuring elongation, particularly with the elastic limit.

It was decided to test a grade of wrought iron made directly from pig. All of the specimens were secured from the same lot, and further uniformity was assured from the fact that the grade was a special one and the iron unusually pure. The specimens were made 1 in. x ¼ in. flats milled down for a length of 5 in. to ½ in. x ¼ in. Flats were chosen because of the ease with which the specimens could be prepared, and because time was an important factor. The overall length of the specimen was determined from the size of the furnace and the necessary additional room required between the heads of the testing machine for the attachment of the extensometer.

An electric furnace was used for heating the specimen. Gas and gasoline heaters were considered, but it was thought that the gases of combustion might have an effect of changing the chemical properties of the iron, particularly in its heated state. The electric furnace was therefore chosen, not only because it eliminated this possibility, but because its construction, operation and control were simple.

In deciding upon the method of measuring temperature, the main considerations were durability, accuracy, simplicity and cost. A copper wire resistance pyrometer was first considered, but the suggestion was abandoned, because of the excessive oxidization of copper when exposed to heat. Platinum resistance was next proposed, but it was discarded in favor of base metal thermocouples which had all of the desired qualifications.

Provision for a satisfactory extensometer was the greatest difficulty encountered in the entire investigation. Strength, rigidity, lightness and accuracy in minute measurement were all essential features. It was necessary to read outside of the furnace, an elongation in five inches of not more than .005 in. A cathetometer was suggested, but the only one available had a least count of .001 in., which was clearly too large for accurate work. A cast-iron rigging was made so that a Berry Strain Gauge might be attached outside of the furnace. This failed to work on account of excessive friction in a sliding arm, and to generally unbalanced forces throughout the mechanism. Finally an instrument was devised that worked well and filled all the requirements. It will be explained later.

The furnace consisted of an inner cylinder of sheet iron 2 in. in diameter and 11 in. long. Around this cylinder is wrapped a layer of asbestos .1 in. thick, on which is wound 18 ft. of nickel-chrome ribbon, the total resistance being about eleven ohms. A sleeve of a special heat-resisting compound surrounds the inner cylinder. A half-inch wrapping of corrugated asbestos sheeting; ends of asbestos board, held together by four rods, and the necessary binding posts, etc., completed the furnace.

The thermocouples were made of iron and constantan wire, twisted together and welded on the ends. The wires were insulated with asbestos. Six of these were made. A Leeds and Northrup Potentiometer, used in connection with a standard cell, storage battery and auxiliary resistances, was used to measure the e.m.f. generated by the thermocouples. The cold end was kept at room temperature and the necessary correction was made. The potentiometer was used in preference to a millivoltmeter on account of the superior accuracy of the former for this class of work.

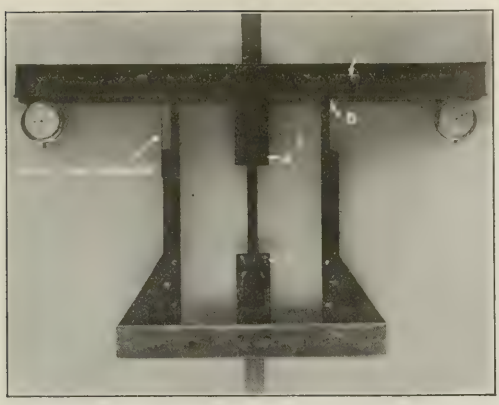


FIG. 1—EXTENSOMETER

The extensometer is shown in Fig. 1. The specimen is gripped by knife edges at *A-A* and the entire extensometer is supported at these two points. The uprights are free to move through the upper beam. A lever, supported by trunnion bearings at *C*, rests with one end on shelf *B* and the other on the movable shaft of a B. L. Ames Dial Gauge. A rubber band keeps this lever bearing continually on shelf *B*. The lever has a five-to-one ratio, the dial has one hundred divisions marked on it, one division being equivalent to the movement of the dial shaft or stem through .001 in. Consequently the least count of the instrument is 1/5 + 1/1000 = .0002 in. Readings of both dials were taken simultaneously and the average of these two readings was taken as the elongation. The grip pieces were made of cast iron; the remainder of the structure was made of No. 26 gage sheet iron, bent into channel forms, to insure rigidity, and riveted together.

CALIBRATION OF THE APPARATUS

Considerable time was spent trying to calibrate the furnace for temperature current relations, and for temperature variation in the inner shell. After such curves had been obtained, the furnace burned out, and it was necessary to rewind it. An attempt was made to secure similar curves for the second oven. The relation of current to temperature is only approximate. There was considerable of what might be called temperature lag; that is, if the oven was brought up to a certain temperature and held at that point, it would require a greater current than if the oven had been previously heated and the current so decreased as to allow the temperature to fall to the same point. Again the temperature lag in certain sections of the oven was different; that is, if the temperature was raised to a certain value, the temperature range in the oven would be quite different than if the temperature were allowed to decrease to the same value. The maximum variation of temperature was never greater than about ten per cent.

Owing to the fact that the temperature had different values in different parts of the furnace, readings of temperature were taken at three points, viz., top, middle and bottom. These were averaged by assuming the

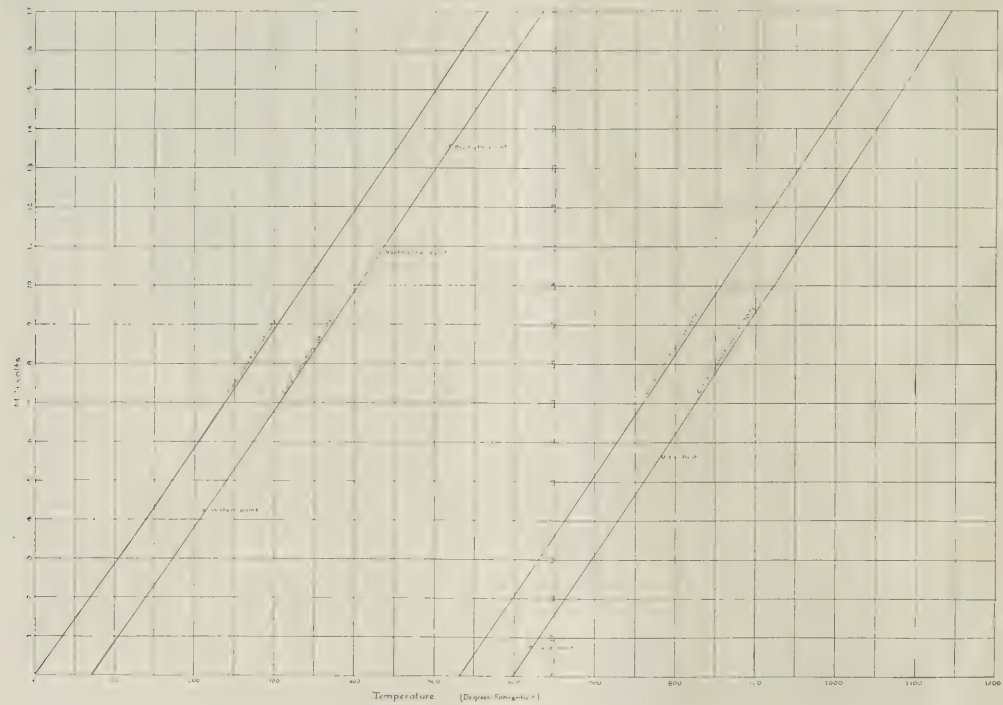


FIG. 2—CALIBRATION CURVE OF IRON-CONSTANTAN THERMOCOUPLE

change to occur along a second degree curve. This average temperature was taken as the temperature at which the elastic limit, modulus of elasticity, and percentage elongation occurred. Since the point in the oven at which the break occurred was readily ascertained, and since the temperature could be obtained at that point by means of a second-degree curve connecting the temperatures of the top, middle and bottom, that particular temperature was considered as the one at which the ultimate strength and percentage reduction of area were valid.

A calibration curve of an iron-constantan thermocouple shown in Fig. 2 was obtained from the Leeds & Northrup Company of Philadelphia. One of the "home-made" thermocouples was compared with this curve at the boiling points of water and naphthaline, and at the melting points of lead, bismuth and zinc. This couple compared very closely with the one for which the curve was drawn, and so it was assumed that for the case at hand the Leeds & Northrup curve was sufficiently accurate.

The other thermocouples, five in number, were tied with the calibrated one so that the junctions of all were as nearly as possible at the same point. They were then inserted in the furnace which was brought up to a fairly high temperature, and the e.m.f.'s generated by each were read almost simultaneously. Each registered the same e.m.f. in recording the same temperature, and so, in connection with the fact that all couples were made from the same pieces of wire, it was considered that this was ample proof that all were alike and answered to the one calibration.

The curve in Fig. 2 shows the Leeds & Northrup curve with the cold junction at zero degree Fahrenheit. A curve is also drawn for the cold end at 70 deg. Fahr. This was obtained by deducting the millivolts corresponding to 70 deg. Fahr., from the millivolts on the zero curve. The various actual points obtained by the calibration are corrected for the difference between room temperature and 70 deg. Fahr., and plotted over the 70 deg. curve. A maximum discrepancy of about 7 deg. Fahr. is observed at the boiling point of naphthaline. The naphthaline used was commercial "camphor," hence impurities present probably altered the boiling point slightly.

The extensometer was checked for accuracy by moving one end of the multiplying lever through a known distance by means of a micrometer screw, and reading the amount of motion on the dial. The error was less than one per cent. Both levers were checked in this manner.

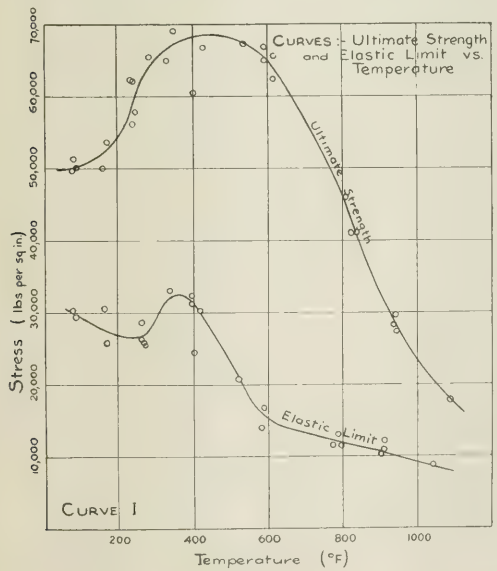
The testing machine was made by Tinius Olsen & Co. It was checked for accuracy by loading the table with known weights and measuring the same on the weighing beam, which had previously been balanced to zero. The error was so slight as to be negligible.

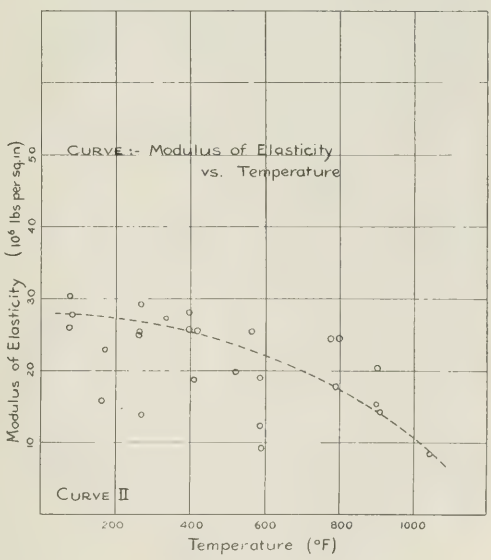
PREPARATION FOR AND CONDUCT OF TEST

Before actually conducting a test there were many preliminaries that had to be repeated for each. The first step was to determine accurately the dimensions of the specimen. The knife-edge extensometer grips were then placed on the specimen 5 in. apart, and made tight by means of bolts. By using knife edges instead of set screws and punch holes, the surface of the specimen was not damaged. In such a small specimen it is probable that a deep punch mark would so reduce the area of cross section as to weaken the specimen considerably at that point and cause the rupture to occur at the grips.

In attaching the thermocouples great care was taken to see that the welded tips were in contact with the specimen, so as to register more nearly the specimen temperature than the oven temperature. Three thermocouples were used in each test, one just below the top knife edge, one in the middle and one just above the bottom knife edge. From the readings of the three, the temperatures throughout the furnace could be closely approximated. These thermocouples were tied securely to the specimen by means of asbestos string.

The specimen and thermocouples were placed prop-





erly inside the furnace, the open ends of which were carefully packed with asbestos to prevent heat leakage. The extensometer was fastened to the projecting lugs of the knife edge grips, and the whole assemblage was finally put in the testing machine. Great care was taken at this point to get the specimen exactly in the middle of the top and bottom grips, so that the pull would be directly along the axis of the specimen.

The balance beam was adjusted to a correct zero reading and the specimen was stressed two hundred pounds for an initial reading.

Each test lasted, roughly, from twenty to thirty minutes. The machine was run at the lowest speed possible, about 1-in. movement of the drawhead per hour. The weighing beam was kept in constant balance, and for every one hundred and twenty-five increment in tension, the dials were read simultaneously. After passing the yield point, the dials would soon reach their limits, and a scale and vernier attached were used for measuring the further elongation to the point of rupture.

SUMMARY AND DISCUSSION OF RESULTS

A complete summary of all tests is given in the accompanying curves.

From these results it appears that the ultimate tensile strength of wrought-iron bars increases as the temperature increases from 70 deg. Fahr., until a maximum is reached between 350 deg. and 550 deg. Fahr.

From the temperature of maximum strength, the tenacity diminishes rapidly until the highest temperatures covered by these tests are reached.

The greatest gain over the strength of the metal at 70 deg. Fahr. was 37.6 per cent. This occurred at 430 deg. Fahr., as judged from curve I, page 69. The loss at 1000 deg. Fahr., over the strength of the metal at 70 deg. Fahr., was 53.5 per cent. A continuation of the curve at 1200 deg. Fahr. indicates a loss in strength of 75 per cent.

The elastic limit appears to decrease from 70 deg. Fahr. to about 270 deg. Fahr., showing a maximum decrease of about 13 per cent. From that temperature the elastic limit appears to suddenly increase to about 350 deg. Fahr., where it reaches its maximum value of about 10 per cent above the stress at 70 deg. Fahr. From here on it gradually drops and at 1000 deg. Fahr. shows a loss of 70 per cent over the elastic limit at 70 deg. Fahr.

Owing to a period of rapid yielding without increase of stress, the yield point is well defined at moderate temperatures. This yield point, however, vanishes at about 500 deg. Fahr., and the stress-deformation curve assumes a gradual slope from the start to finish.

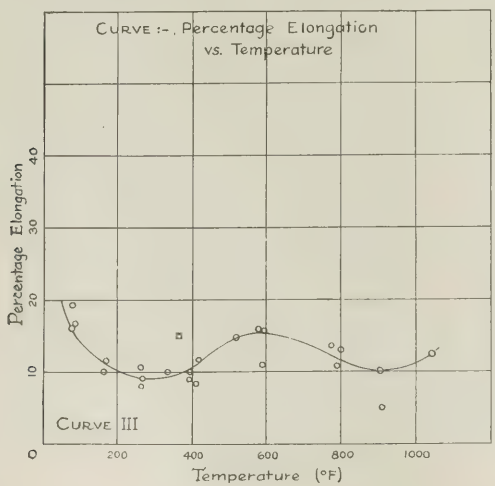
With reference to elongation under stress, this peculiarity is noticed: That greater rigidity exists under certain stresses at intermediate temperatures than at either higher or lower temperatures. Thus it will be noticed in Curve III that at 300 deg. Fahr. and 900 deg. Fahr. the metal shows only about half the elongation that it shows at 70 deg. Fahr. It is surmised that beyond 1000 deg. Fahr. the curve gradually rises and the metal exhibits powers of greater ductility as it approaches a workable heat.

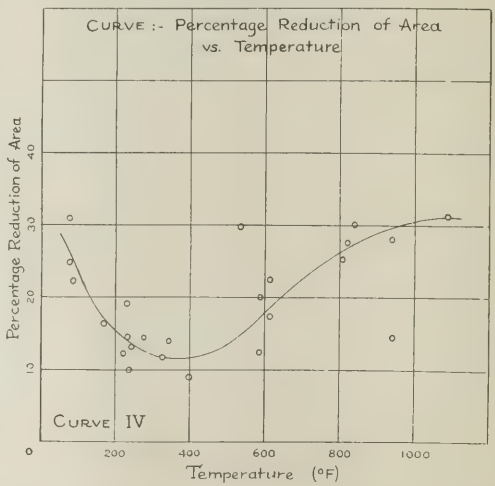
Other remarkable features in the elongations are found in bars tested at temperatures varying from 200 deg. to 400 deg. Fahr., in which there are displayed alternate periods of rigidity and relaxation under increasing stresses, resembling and yielding described as occurring with bars immediately after passing the elastic limit.

It will be readily observed how irregular Curve II is beyond the yield point. Some of the tests taken at this temperature showed even greater irregularity. The repetition of these intervals of rigidity and relaxation is suggestive of some remarkable change taking place within the metal in this zone of temperature, conspicuous in a series of tests possessing many remarkable features.

The contraction of area at the place of rupture varies with the temperature of the bar. It appears that the contraction of area of wrought-iron bars is a great deal less between 200 deg. and 600 deg. Fahr. than at 70 deg. Fahr., and within this range of temperature there is a tendency to fracture obliquely across the bar.

The results obtained for the modulus of elasticity have very little value, except that they indicate a gradual decrease. The length over which the stretch was measured (five inches) was too small to obtain an accurate





value of elongation within the elastic limit. The points obtained by the extensometer up to an elongation of .0008 inches were seldom of value, since it took nearly that long to get the test "under way." In drawing the average straight line through a series of points up to the elastic limit, the least difference in slope would make an appreciable difference in the elongation as measured by the abscissae. In some cases the least count in this elongation amounted to 5 per cent of the total, and in computing the modulus a variation of 5 per cent would mean a variation of perhaps a few millions. Consequently no curve was traced through the points, but instead a dotted curve was drawn showing the variation that might be expected according to the results obtained by other investigators (Curve II).

In all cases the temperatures recorded were those at the surface of the specimen. The accuracy of this method might be questioned, e.g., whether or not the recorded temperature was the actual temperature of the iron. This was investigated by drilling a hole in a specimen, inserting a thermocouple so that the welded tip was in the central part, and then carefully plugging up the hole so that no heat could get in by air conduction. It was demonstrated by taking the inner temperatures and the outer surface temperatures simultaneously that a maximum difference of thirty degrees might be expected at the highest temperatures. At low temperatures the difference was almost negligible. Consequently the authors felt justified in using the surface temperatures throughout, since the maximum error would only be a few per cent and the curves would not be changed appreciably.

It is shown conclusively that should similar iron be used in work where the design factor of safety was five, and where the temperatures were 900 deg. Fahr. or above, the part under consideration would be stressed beyond its elastic limit if the allowable stress was applied. Furthermore, at that temperature the factor of safety on the ultimate strength would be reduced to three. Curve I shows the relation of ultimate strength to elastic limit throughout the complete temperature range.

For tubes, valves, pipe lines, etc., carrying superheated steam, Curve I shows that at 600 deg. Fahr. the elastic limit has fallen 50 per cent of its value at ordinary temperature, hence a design factor of safety in superheater construction should be so modified as to give an ample factor on the elastic limit at this temperature. Assuming that the factor of safety is five on the ultimate strength at 70 deg. Fahr., this would be equivalent to a factor of three on the elastic limit at the same temperature. Therefore, considering that the metal should never be stressed to more than one-third of its elastic power, at 600 deg. Fahr., the factor of safety would have to be ten on the ultimate strength of the metal at 70 deg. Fahr.

Boiler temperatures do not come so high that it would be necessary to change the factor of safety in their design.

With reference to the metal rigging above large crucibles and ladles as previously mentioned, it is not known just what temperatures are reached, but they are probably as high at 600 deg. or 800 deg. Fahr., in which case it is clear that some allowance must be made for the temperature service alone.

Reference to Curve III indicates that the metal is very brittle between 150 deg. Fahr. and about 1100 deg. Fahr. Where this state exists it is, of course, impractical to work the metal. In other words, it would be better to work the metal cold than at 200 deg. Fahr., at which temperature it might fracture without warning. Nine hundred degrees Fahrenheit is even a more critical point, for here the ultimate strength and the elastic limit have dropped to less than half their original values.

The conclusions attained are rather startling. The wide fluctuations in the physical properties are not generally realized, and it seems that the field for further research is a wide one. An exhaustive series of experiments along the general lines of this investigation, on different grades of iron, steel, brasses, etc., and the publication thereof, ought to benefit the world of commercial design to a great extent. A microscopical analysis of the structure of the metals after having been broken at different temperatures, would very likely show interesting results, judging from the superficial examination of the breaks in this experiment. Tests conducted while the iron was in its recalescent stage would prove likewise an exceedingly interesting field for investigation.

REFERENCES

(1) "The Change of the Modulus of Elasticity and of the Other Properties of Metals with Temperature," by Prof. F. C. Lea and O. H. Crowther, published in *Engineering* Oct. 16, 1914.

(2) "Strength of Mild Steel at High Temperatures," published in *Engineering* March 30, 1906.

(3) "Versuche über die Festigkeitseigenschaften von Flüsseisenblochen bei gewöhnlicher und höher Temperatur," by Prof. C. Bach of Stuttgart, published in *Die Zeitschrift des Vereines Deutscher Ingineur,* August and September issued in 1904.

(4) "Experiments at the Watertown Arsenal," by the United States Government, published in the Proceedings of the American Society of Naval Engineers, 1888.

Reference No. 1 deals with several metals including mild steel. The authors apparently have very good results for the modulus of elasticity, and they obtained values for ultimate strength and reduction of area very similar to those obtained in this investigation. It is possible, perhaps, that with the grade of metal used a definite yield point was obtained at as high a temperature as 550 deg. C. However, for most wrought iron and mild steel, it is impossible to obtain a definite yield point as indicated by the drop of the beam, after 500 deg. Fahr. or 260 deg. C. has been reached. This statement is confirmed by the experiments at the Watertown Arsenal in 1888, and by the investigations of Prof. C. Bach in 1904.

Reference No. 2 is merely a digest and translation of No. 3 by Prof. C. Bach, who reports very similar behavior to that observed in this investigation.

Reference No. 4 is the most complete treatise on record, and while the investigations herein disagree on minor points, still in main the phenomena observed are identical. This reference is the only one that contains any information concerning the elastic limit of the metal. Several grades of iron and steel were investigated, and it is noteworthy that they all showed similar characteristics.

Rubber Soles

By Andrew H. King

For quite a number of years we have been familiar with the type of rubber soled shoe known in the trade as "tennis." These slippers are made in many grades and styles. The most general characteristic has been cheapness. In fact, many of them are so cheap as to be next to worthless. Do not misunderstand me—there are good makes of tennis shoes, but to get them one must pay money. Because of this general cheapness both in price and in quality the public has come to look on a rubber-soled shoe as not exactly high class. That this is a mistake is now being forced home by extensive educational advertising.

Within the past two years the price of leather has advanced something like 120 per cent, and in fact genuine oak tanned leather is to-day extremely hard to get at any figure. People must have shoes, and since leather is beyond their reach a substitute must be found. Many times in the past the substitute has proved far superior to the original article. This case has been no exception, for with comparatively little effort rubber manufacturers have been able to turn out soles in every way equal, and in many ways superior, to any leather sole ever made.

The next step is education. Shoe manufacturers have had to learn the difference between rubber and leather. These differences while not great are nevertheless important, and the ways of building shoes have had to be altered a little to suit the new conditions. Shoemakers have done this because they were convinced of the virtue of rubber soles. The general public has been a bit skeptical, mainly because of the subconscious memory of the old tennis shoe. The best argument, perhaps, is in the appearance of high-priced $8, $10, and $12 rubber soled shoes bearing the name of reputable manufacturers. Last year rubber soles were a fad. To-day they are a necessity.

There is quite a little psychology in it. For a thing to be appreciated by the people at large there must be a perfect whirlwind of enthusiasm, a craze, a sort of mono-mania. In time this subsides and the great outstanding utilitarian virtues of the thing are generally accepted. It is not long ago that bicycles were the fad. Then the bubble burst, people's attention was directed elsewhere. Sales fell off and prices with them. But the bicycle was not done for. It has a place in the world because it is of use. To-day we have the three-speed bicycle and the motor wheel attachment. It is here to stay.

Tango dancers long ago discovered the usefulness of the rubber sole. In fact, the modern dances almost without exception, would be impossible without them. Then the thing became a fad. We are still in this stage, and of course are paying fad prices. It might be possible that a good all-leather dress shoe cannot be retailed for less than $8 a pair, but certainly this is a high figure when the soles are of rubber. Necessity for the craze has now passed. People know that a first quality sole can be made of rubber, and the next thing is to bring it down within range of their buying power.

The chief advantages of the rubber sole over the leather one are:

(1) Greater wearing power; *i.e.*, longer life.

(2) Being by nature absolutely waterproof.

The rubber sole properly made will last anywhere from two to three times as long as the leather one. This consideration is by far the most important. Theoretically, for good shoes the uppers and the soles should wear out at about the same time. Ordinarily a shoe will stand at least two more sets of leather half soles and heels. Consequently with a good rubber sole this theoretical condition is more nearly approached.

Leather is a porous, fibrous substance and to be made waterproof requires the use of large quantities of various waxes and greases. Rubber is non-porous and watertight by nature. This fact constitutes the main objection to the rubber sole, for not only is it watertight, but airtight as well. It is claimed that leather allows the feet to breathe and in this way prevents burning. However, this is really only a minor point and can be remedied by using canvas uppers or by some form of a ventilator.

Another objection is that a rubber sole tends to slip on a wet pavement. With the first ones it was hardly possible to walk with them on rainy days. This trouble has now been almost entirely done away with by incorporating into the rubber cotton fiber or ground leather, or both. Consequently as the sole wears away a surface is produced which will absorb a little water and thus prevent slipping.

The first rubber soles were quite heavy. It did not seem possible to prepare a stock with the desired stiffness, strength, and quality without having it also of high specific gravity. This was not to be thought of, for the addition of even half a pound to the weight of one's shoes has an effect quite noticeable at the end of a day's work. The introduction of ground cotton waste and leather dust as compounding ingredients made it possible to bring the gravity down to 1.25-1.35.

The manufacture of soles is quite simple. It may be outlined as follows:

(1) *Preparation of the cotton fiber:* Various kinds of rags and trimmings, depending mostly on the color and quality of the sole, are put through a shredding, grinding, and fluffing process. In the end the fibers are reduced to not much more than 1/32 in. in length.

(2) *Preparation of leather dust:* Trimmings from the shoe factories and repair shops are ground very fine, and usually are air separated. It is customary also to make up a master rubber by milling in a considerable percentage of the dust and refining it a number of times to remove the lumps. This master rubber is weighed up and mixed as usual in the main batch.

(3) *Rubbers:* Depending on the quality of the sole more or less rubber and shoddy are used. These are of the common grades. The shoddies must, however, be of low gravity. The backbone of the sole business is reclaimed auto-friction. This is the rubber-coated duck used in the building of the carcass of auto tires. Whether this building is done by hand or by machine there is an enormous amount of trimmings to dispose of. These trimmings carry quite a lot of unvulcanized rubber, which is of better quality and higher purity; *i.e.*, with less compounding material, than that of any other place in the tire. The rubber is either reclaimed by a modified acid process or extracted with solvents. In the latter case both the rubber and the fabric is usable, whereas in the former the cotton is destroyed. However, the extraction process requires very careful supervision to be profitable, and it is a question as to which

method is the more economical. The reclaimed rubber is of high quality and low gravity, and makes a highly satisfactory sole. As would be expected, by far the largest portion of rubber soles and heels are made by the large tire companies.

(4) *Milling:* The actual preparation of the batch is not difficult and is carried out on ordinary rolls in the usual manner.

(5) *Calendering:* The stock is plied up very carefully to the desired thickness and sent in rolls to the cutting room.

(6) *Cutting:* The soles are stamped out by means of dies in a cutting machine. The dies are carefully adjusted so that there shall be but very little overflow during the cure.

(7) *Muring:* This is accomplished in molds in the usual way. The trademark, name of maker, and any special marks are put on in the mold. The cure is usually short but with a high steam pressure. 25 minutes to 60 lb. is not uncommon.

(8) *Trimming:* Usually done by girls, on regular trimming machines.

(9) *Varnishing:* Accomplished ordinarily by dipping. Either a spirit or water varnish may be used. It gives the sole a nicer appearance and prevents blooming.

Following drying, the soles are ready to be packed and shipped to the shoe makers.

A good sole will have a tensile strength slightly in excess of 1000 lb. per square inch, but will have a very low stretch. It must not be brittle nor break across when given a surface cut and then bent double.

For very rough, heavy shoes, such as are worn by teamsters, iron workers, and railroad section men a new sole is coming into favor. It consists of a number of plies of heavy duck built like a belt, and stamped out to size with a die. Rubber or balata is used to cement the plies together. Such soles have rather unsightly edges but from the standpoint of service they are very satisfactory.

To the keen observer it must be apparent that leather shoes are going, in fact have gone, beyond the means not only of the poorer classes but that of the better middle classes as well. War conditions and speculation are largely to blame. It is the American way to beat such a condition not entirely by legislation but by invention—invention of a substitute.

A number of rubber soled shoes with canvas uppers are now being placed on the market. Canvas uppers can be waterproofed if desired in a number of ways. For instance, they can be waxed, rubber coated, or built of three plies, the inside one of fabric which has been frictioned and skim coated on both sides. The present offerings are but feelers which will, no doubt, be followed up with a good, all-around canvas-rubber shoe. Such a shoe must be neat appearing, serviceable, and have a long life. There is certainly no reason why it cannot be made.

Steam Packing.—French chemists have found a specimen of klingerite (a German steam pipe joint packing) about a sixth of an inch thick to consist of 15 thicknesses of thin asbestos. Analysis showed 80.5 per cent of asbestos, 2.2 of cellulose (flax), and 17 of rubber and balata, with a small proportion of sulphur.

Modern Concentration of Colorado Tungsten Ores—II

By S. Fischer, Jr., Ph.D.

(*Concluded from Vol. XVI, p. 565*)

The Black Prince Tungsten Mill

This mill is situated at Ferberite in Boulder Canyon about seven miles from Boulder, Col. The plant handles its own ores from the group of the Black Prince mines, many of which are operated by leasers. The ore runs from 1.5 to 60 per cent tungstic acid, the high-grade material being shipped directly without passing through the mill. The capacity of the mill is 25 tons per day. It is at present contemplated to increase the capacity of the mill to 75 tons per day. The concentrator is operated by electricity, the power coming from the Colorado Power Co. The mill uses three Westinghouse motors of 15, 7.5 and 10 hp.

The general flow sheet of this concentrator is similar to those shown with the exception, that a Denver quartz mill is used for fine grinding instead of a ball mill. This mill is of the Chilean type and it is claimed gives very satisfactory results in this instance, producing a very uniform product of the desired mesh. Fig. 1 shows the flow sheet of this mill.

The ore from the mine run passes to an 8 in. x 12 in. Denver steel crusher, the oversize passing to a set of 12 in. x 20 in. McFarlane-Eggers rolls from where it is elevated to the fine ore bin together with the undersize from the crusher. The material from this bin is fed to a No. 2 Denver ore feeder and goes to a 12 in. x 12 in. Richards jig. The jig concentrates are collected, dried and sacked for shipment. The tailings from the jig go to a No. 1 Denver quartz mill where a 30 mesh product is obtained. This product then passes to a Loves classifier and dewatering device. The overflow and slimes from this last combination are fed to a Callow cone, from which the overflow is conducted to the canvass plant and the thickened slime to a Monell slimer.

From the first dewaterer the coarse pulp is conveyed to one side of an Isbell concentrator, the high-grade concentrates are collected, the middlings pumped back

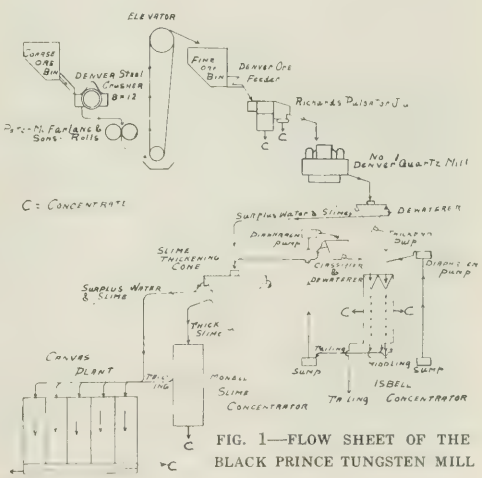


FIG. 1—FLOW SHEET OF THE BLACK PRINCE TUNGSTEN MILL

to the head of the table and the tailings are pumped to a classifier. The overflow from this classifier goes to the Callow tank and the sands to the opposite side of the Isbell concentrator.

The low-grade concentrates from this side of the Isbell are collected. The middlings are returned and the tailings go to waste.

Of particular interest are the following items, which the writer in this instance is at liberty to mention: from the assays shown the mill is making a saving of 84.3 per cent. The heads run 1.3 per cent tungstic acid and the tailings 0.22 per cent.

Fig. 2 shows the mill as it looks at present. The mines and mill are owned by John T. Duncan, of Boulder, Col.

The Tungsten Mines Co

The Tungsten Mines Co.'s mill and mines lie about two miles north of Rollinsville. The mill was built in 1910 and is owned by a few individuals. The ore from the mine runs to a Denver crusher, the oversize passing to 12 in. by 20 in. McFarlane-Eggers rolls, thence to two No. 1 Denver Quartz mills and from here to a classifier. Wilfley tables and Monell slimers are used at the plant. It might be stated here that as a general rule Wilfley tables are preferred to Isbell concentrators throughout the district. No data as to the percentage extraction could be obtained, but the mill was operating successfully even at the time when tungsten was selling at $7 per unit.

The Intermountain Tungsten Mill

This company owns the Black Swan mill at Salina, Col. The concentrator handles partly its own ores and partly the custom ores from neighboring mines.

The flow sheet of this as well as the mill of the Tungsten Mines Co. is in general similar to the one of the Black Prince mill, only that in both of the last two mills Wilfley tables replace the Isbell concentrators. The Black Swan mill has one more distinctive feature in that it uses stamps. The ore is crushed by an 8 in. x 12 in. Denver crusher. From this crusher the material passes to ten stamps, is then classified, and the oversize reground in a No. 2 Denver quartz mill. From here the product goes to Wilfley tables and Akins and Evans slimers. Finally the fines pass to a stationery canvass plant.

The Luckie 2 Mill

The flow sheet of the Luckie 2 mill is given in Fig. 3. The plant handles 25 tons of ore per day which comes from the company's own mines. The mine ore comes to eight bins of 8 tons capacity each. From these bins it passes to an 8 in. x 12 in. crusher and then to 12 in. x 20 in. McFarlane rolls where it is crushed to 1-in. size. This material then is passed over a trommel screen with ¼-in. openings. The undersize is sampled by a Vezin sampler, the reject going to the bin containing as a maximum ¼-in. size. The oversize is sent through a second set of McFarlane rolls in closed circuit with the trommel screen until all is reduced to at least ¼-in. size, when it also passes into the bin mentioned.

The material from the ¼-in. bin, as well as any custom ore which is kept on the floor enters a vibrating screen. This screen has 12 mesh openings. The plus 12 mesh product passes directly to a Richards pulsating jig, which yields concentrates which are collected from the top of the screen, dried and sacked. The material passing through the screen goes to a Denver quartz mill and then to a hydraulic classifier. The

FIG. 2—BLACK PRINCE TUNGSTEN MILL

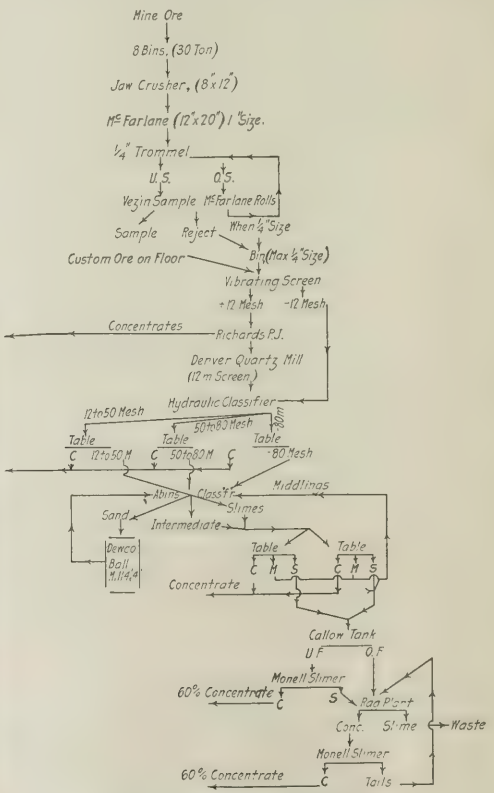


FIG. 3—FLOW SHEET OF LUCKIE 2 MILL

minus 12 mesh product from the vibrating screen passes directly to the classifier.

The hydraulic classifier yields three products: the first ranges from 12 to 50 mesh, the second from 50 to 80 mesh and the third is minus 80 mesh. All these products go to three Wilfley tables where only the concentrates are collected, the rest of the material passing to an Akins classifier. This latter gives sand, an intermediate product, and slimes. The sand circulates between a ball mill and the classifier until slimed, when it is distributed to two Wilfleys. The slimes and the intermediate product go to the same tables without any further treatment. The concenrates from these tables are collected for shipment. The middlings return to the classifier and the slimes go to a Callow tank. The over-flow from the Callow enters the "rag plant," while the underflow is passed over a Monell slimer, the slimes from this then going to the "rag plant."

The "rag plant" consists of two tiers of six tables each. The lower tables are 6 ft. x 36 ft. while the upper ones are 6 ft. x 26 ft., thus giving a total canvass area of 2232 sq. ft. The slimes from the "rag plant" go to waste, while the low-grade concentrates pass over a Monell slimer giving a 60 per cent concentrate and tails which are returned to the "rag plant." The mill endeavors to produce 60 per cent concentrates throughout the operation, which are sold to the Tungsten Products Co. of Boulder. The ore treated at this plant averages about 7 per cent tungstic acid. Fig. 4 gives a general view of the mill.

Some features at this mill are worthy of notice. The Denver quartz mills used are employed as intermediate grinders only, the Dewco ball mill doing the final fine grinding. It is claimed that with this arrangement the large bulk of material handled per day is crushed to the fine state in a shorter time than if the quartz mills were used alone. The rag plant circulating system is the other item worthy of notice. Finally it should be stated that the flow-sheet presented in this article is not the one embodying the mode of operation at the time of the author's visit, but is that of the final mill, including new features and machines.

The Mill of the Rare Metals Ore Co.

Both from an engineering and an efficiency standpoint this mill undoubtedly is one of the finest examples of the district. The mill treats custom ores and is able to handle 50 tons of 1.5 per cent material or 25 tons of 4 to 5 per cent ore. The practice at the mill is to state the number of units of tungstic acid handled per 24 hours rather than the tonnage of ore treated in the same length of time. In other words the plant handles 100 to 150 units of tungstic acid per day. The average mill ore runs 4 per cent tungstic acid.

FIG. 4—LUCKIE 2 MILL

Due to the fact that this mill is a typical example of efficient engineering its flow sheet was given at the beginning of this paper (see this journal, May 15, 1917, Fig. 1, p. 560). The flow sheet may be divided into two concrete parts, the sampler flow sheet and the mill flow sheet. On entering the mill, the ore is weighed and transferred to receiving bins. From these bins the product is passed through a 10 in. x 16 in. Blake crusher where the ore is reduced to 1.5-in. size. No. 1 elevator raises the crushed material to a set of rolls (14-in. x 27 in.) reducing the product to ½ in. This ½-in. material is sampled by a 36-in. Vezin sampler, which takes a 1/5th cut. The reject goes to the No. 2 elevator from where it is passed into the mill bin, containing as a maximum size ½-in. ore. The sample from the Vezin passes through a set of 12 in. x 20 in. rolls where a reduction to ⅛ in. size takes place. This material is again sampled by a 20-in. Vezin taking a 1/5th cut. The reject passes to the No. 2 elevator and from there to the mill bin. The second sample is coned and quartered to a 20 lb. sample, dried, ground and rifled to assay pulp.

From the mill bin the ore passes into the mill proper through a plunger feeder which feeds to the No. 3 elevator. From here the product goes to an impact screen with ⅛-in. openings. The oversize from the screen is passed through the No. 1 set of 14 in. x 27 in. rolls from where it goes back to the No. 3 elevator. The undersize from the impact screen is fed to the No. 2 impact screen having 1/16-in. openings. The oversize from this screen passes to a two-compartment Hartz jig, which gives concentrates, a hutch product and a third product which latter passes over a dewatering screen and from here goes to the No. 2 5.5 in. x 20 in. high-speed rolls which reduce the product to 1/16-in. size. This then enters elevator No. 3 to continue its passage through the mill.

The underflow from the No. 2 impact screen goes to a two-compartment hydraulic classifier the overflow of which is conducted to a 36-in. Akins classifier. The underflow of the one compartment of the classifier unites with the hutch product from the Hartz jig and goes to the No. 1 Wilfley table. The underflow from the other compartment of the classifier goes directly to a No. 2 Wilfley. The Hartz concentrates are collected, dried and sacked. The same holds true for the concentrates from the first two Wilfley tables. The middlings from No. 1 and No. 2 tables pass through a hydraulic pipe classifier, giving a spigot concentrate running between 55 and 60 per cent tungstic acid. The second product of this classifier goes back to elevator No. 3.

The Akins classifier receives material from the dewatering screen from elevator No. 4 and from the ball mill. It yields three products, the slimes of which go to the Callow tanks, the intermediate product which are classified and the sands which are slimed in the ball mill. The ball mill, which is of the Colorado Iron

Works type, is 4 ft. x 3 ft. and is in closed circuit with the Akins classifier and elevator No. 4.

The slimes after treatment in the Callow tanks yield two spigot products, each of which goes to a separate Deister slimer, the concentrates of which are collected, the middlings going to elevator No. 4, while the tailings go to the "rag plant." The overflow from the Callows unite and enter the "rag plant." The intermediate product from the Akins is classified in a hydraulic classifier, the spigot product of which goes to Wilfley table No. 3 while the overflow goes to Wilfley No. 4. The distribution of the table products is identical with those obtained on the Deister slimers. The overflow from the sand classifier goes to seven canvas tables each being 6 ft. x 24 ft. and set at a drop of $\frac{3}{4}$ in. per foot. The spigot product from the sand classifier goes to the tails ponds. The concentrates from the canvas tables are pumped back to elevator No. 4 by means of centrifugal pumps.

This mill produces concentrates of at least 60 per cent tungstic acid content. The extraction is remarkably high, but the writer is not at liberty to give the exact figures. To attain this high mark of efficiency various novel features are connected with the construction of this mill. As is seen from the flow sheet, the sampling of all the ores is accomplished with the greatest of care. The only mechanism which did not come up to the expected standards of efficiency is the distributing elevator No. 2, the moving shute of which is rather a detriment than an asset, due to the wear and the labor involved in its manipulation.

In the choice of the machinery for the mill proper the greatest care has been exercised. While the flow sheet may seem complicated, one is struck with the compactness and neatness of the plant on visiting the same. The whole scheme then seems simple and is readily understood. Attention should be drawn to the arrangement of the No. 1 and No. 2 rolls and of the use of high-speed rolls on the dewatered Hartz jig product. The handling of the middlings from the Wilfley tables No. 1 and No. 2 is novel and affords a considerable saving. This product passes through a hydraulic classifier, designed by the staff of the mill, which is locally known as the "hickey." The spigot product is of commercial grade and saves this material from again passing through the mill.

The treatment of the intermediate product from the Akins classifier is also worthy of notice, as most of the local plants handle only two products from this classifier, the slimes and the sands.

The water supply to the canvass tables at this plant are also distinctive. Instead of having the regular Wilfley type of feed, these tables taper toward the upper end, the water entering at the apex and being distributed at will by movable guides as shown in Fig. 5.

Provisions for cleaning up the mill floor have also been made, the floors being inclined toward elevator No. 4. From time to time the floors are washed with a hose, the material gathered in the elevator and sent through the mill. Even the workmen undergo a daily washing, provisions being made for shower baths. The "efficiency" of this latter process has however not been calculated.

It is really astonishing to see how much one may save by supervising the small losses. For instance, at this plant the ashes from the drying furnaces are saved every day and when a sufficient amount has been collected it is again passed through the mill. This amount figures approximately 6 lb. of tungstic acid saved per day.

As this plant represents the successful practice in the ore dressing of the Nederland tungsten district, the complete plans of this mill are given in Fig. 6.

The Tungsten Losses

As has been stated in the earlier part of this paper, as much of the values as possible should be eliminated from the ore before fine grinding. Before the installation of the "rag plant" at the mills the tailings went to waste. These tailings carried values which in the modern practice are to a large extent recovered. Some very careful tests were run on the various tailings according to the various meshes, for the tungstic acid content, just before entering the "rag plant." The results are taken from the tails of the Rare Metals Ore Co.'s mill and are given in the following table:

Mesh	WO_3 Content	Percentage Loss
20-40	0.63	2.0
40-60	0.57	6.9
60-80	0.375	7.0
80-100	0.365	2.0
100-200	0.275	10.1
-200	1.41	66.0
		100.0

These data indicate, that by far the largest percentage of the losses are found in the -200 mesh material. At present, with the use of the "rag plant," the tailings as they leave the mill and enter the settling ponds carry approximately 0.75 per cent tungstic acid as losses. Of these losses 66 per cent are contained in the -200 mesh material. It has been experimentally ascertained, that only 31 per cent of the 66 per cent losses could be recovered in these ponds. This demonstrates the great difficulty encountered in endeavoring to recover any large amount of values from the losses in the finest tailings leaving the mill. It is claimed that the installation of the "rag plant" in a mill saves

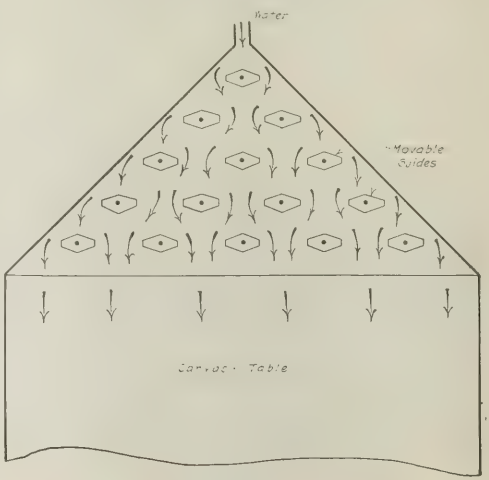


FIG. 5—WATER FEED TO CANVAS TABLE

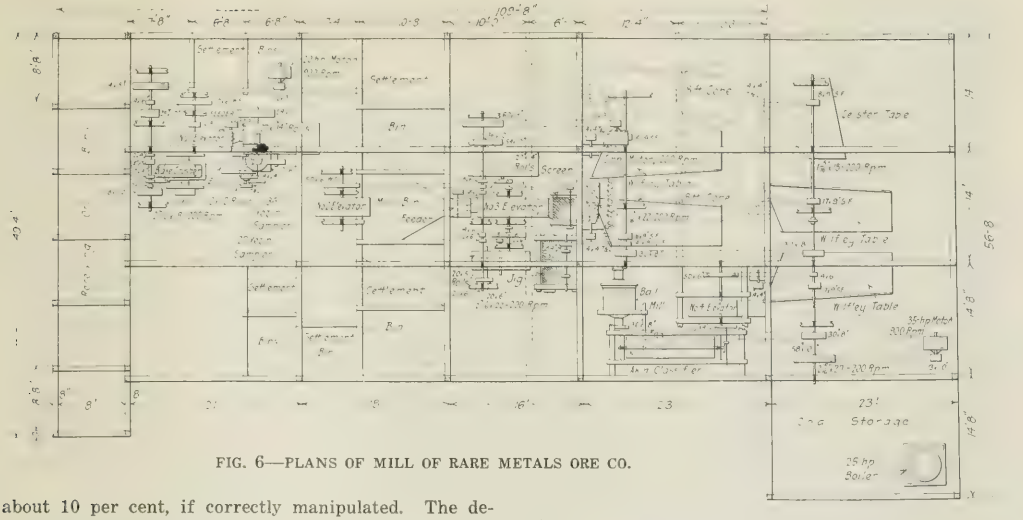


FIG. 6—PLANS OF MILL OF RARE METALS ORE CO.

about 10 per cent, if correctly manipulated. The dewatering of the pulp before sending it onto tables in connection with the installation of a "rag plant" at a concentrator will procure a saving of approximately 15 per cent.

Future Improvements in the Ore Dressing Methods of the District

As the ore dressing methods for ferberite ores have reached a high state of refinement, it is hardly possible that there will be any further striking features along the lines of improvements. The main trend will be to increase the percentage of extraction. Endeavors will be made to eliminate more of the values before fine crushing, to dewater the pulp before going over the tables and to cut down the square feet of the canvass in the "rag plant" to a minimum. These little phases will in all probability be kept secret by all the companies, so that new material will be rather difficult to obtain, until that time when such features as flotation and magnetic separation have been more thoroughly investigated.

Attempts to use both flotation and magnetic separation have been made at various mills in the district, but the results obtained seem to discourage either practice. It is, however, unfair to say that both these methods are of no value in the practice of the district. The work done along these lines seems, as far as the writer could discover, insufficient to justify giving a final verdict upon the subject. The ores of the district are rich enough to guarantee enough concentrates for the present. In time, however, the recovery of the values in the very low-grade materials will have to be taken into consideration and then either one or the other or in all probability both of the methods mentioned combined with a previous roast may prove of value.

It might be stated here that the practice in the dressing of tungsten ores as developed in Boulder County is of the highest standard and there is no reason why the same methods of concentration might not be used on any of the commercial tungsten ores, such as scheelite, wolframite and huebnerite. The specific gravity of scheelite varies from 5.9 to 6.1 and that of both wolframite and huebnerite is 7.2, being practically the same as that of ferberite. The latter mineral is a modification of wolframite with little or no manganese.

The Future of the Metallurgy of Tungsten

The main use of tungsten is in the manufacture of tungsten steels for various uses, such as for high-speed tools and as used in the manufacture of ammunition. Furthermore, tungsten has an industrially very important field in the manufacture of filaments for incandescent lamps, though the quantity of tungsten consumed for this purpose, as compared with the consumption for tungsten steel, is insignificant. While the demand for the metal, due to the present war is considerable, the feeling among the miners of tungsten ores is that after peace has been declared, the tungsten market will suffer, due to the lack of demand for the metal or tungsten alloys in the arts. The feeling is prevalent in the district, that more work should be done respecting the use of tungsten in the arts so as to insure the future of the industry. There can be no doubt, however, that tungsten steel will play a very important part in the reconstruction period after the war.

Some think that the greatest danger confronting the tungsten metallurgy would be the discovery of large molybdenum deposits. The one great drawback in the use of tungsten for steel is the large amounts required to produce the desired effects in the steel, and it is claimed that molybdenum on the other hand produces the same qualities in steel using one-third the amount of this metal as compared with tungsten.

Small deposits of molybdenum have been located not only in Colorado but also in other parts of the United States, but from a commercial point of view, their working has received little consideration, due to the small amount of material available. Then, too, the dressing methods for molybdenum ores have not been developed sufficiently to guarantee their economic working. The largest molybdenite deposits so far known are in the Province of Ontario, Canada. These deposits have been studied by the Canadian Bureau of Mines as to their nature and extent. Metallurgical methods best suited for their concentration have been investi-

gated. In tests run at the laboratories of said bureau, and extending over a period of approximately two years, it was found, that the most suitable procedure would be to coarse grind the ore, separate the flaky concentrates as far as possible during this stage, then fine grind the rest of the material and subject it to flotation by water. Extractions as high as 84 per cent were obtained and it is claimed that in practice the percentage extraction would, in all probability, be considerably higher. While the prices of molybdenum, molybdic acid and ferro-molybdenum are higher than the prices for the corresponding tungsten products, the smaller amounts of molybdenum required to produce the desired effects in steel would by far offset the lower prices of the tungsten products. This undoubtedly would mean that molybdenum would be preferred in the steel industry for the manufacture of tool steels and ammunition.

Conclusion

In conclusion the writer wishes to express his sincerest gratitude to the following gentlemen for their kind assistance and their valuable information: Mr. W. F. Bleecker of the Tungsten Products Co., Mr. C. A. De Witt of the Wolftongue Mining Co.; Mr. J. G. Clark of the Tungsten Production Co.; Mr. G. B. Tyler of the Rare Metals Ore Co.; Messrs. John Connors and T. McGrath of the Vasco Mining Co.; Mr. H. B. Holmes of the Luckie 2; Mr. J. S. Bartley of the Denver Quartz Mill & Crusher Co.; Messrs. H. B. Lowden and R. P. Akins of the Colorado Iron Works and Mr. J. H. Flood of the Hendrie & Bolthoff Mfg. & Supply Co.

British Standard Nomenclature of Bituminous Material

FIRST GROUP—TAR PRODUCTS (PRINCIPALLY COAL TAR AND PITCH)

1. *Tar.*—Tar is the matter (freed from water) condensed from the volatile products of the destructive distillation of hydrocarbon matter, whether this be contained in coal, wood, peat, oil, etc. A prefix such as coal, gas-works, blast-furnace, etc., must be added to the word "tar" to indicate the source of origin.

2. *Pitch.*—Pitch is the solid or semi-solid residue from the partial evaporation or distillation of tar.

SECOND GROUP—BITUMENS AND ASPHALTS

3. *Bitumen.*—Bitumen is a generic term for a group of hydrocarbon products soluble in carbon disulfide, which either occur in nature or are obtained by the evaporation of asphaltic oils. The term shall not include residues from paraffin oils or coal tar products.

4. *Native Bitumen.*—Native bitumen is bitumen found in nature, carrying in suspension a variable proportion of mineral matter. This term shall not be applied to the residuals from the distillation of asphaltic oils.

5. *Asphalt.*—Asphalt is a road material consisting of a mixture of bitumen and finely graded mineral matter, ranging to such a size as will pass through a sieve having square holes of ¼-in. side.

6. *Native or Rock Asphalt.*—Native or rock asphalt is a rock which has been impregnated by nature with bitume.

The committee recommends that prefixes denoting the source of origin should be attached.

The Possibilities of Developing an American Potash Industry[1]

By Richard K. Meade

About a month ago this paper was started by quoting Professor Ostwald's well known remarks concerning Germany's ability, through her control of the only known large deposit of potash salts, to say which of us "uncultured" nations could eat and which would do without our meals. Since making this beginning, however, we have read about a dozen papers on potash and several prospectuses of proposed potash producers, all of which have taken great pains to quote the professor and generally to show him the error of his ways; hence I have recast my introduction and will only refer to Ostwald's remarks by saying this: I know of some millions of dollars which would be invested in establishing a potash industry in this country if we could be sure Germany would be inclined to exact stiff terms from the United States, or dictate that she should go hungry. The thing which keeps this money out of such an investment is the fear, not that we won't have potash from Stassfurt as heretofore, but that we will have too much and that the German producers will be so glad to get Yankee dollars to pay their war debts that they will offer us potash on the same old $40 basis.

If the American investor after the war can be insured against the dumping of German potash salts into this country at prices too low for us to reach, I know that we can develop a potash industry in this country and in Canada which can more than take care of our needs for both agricultural and chemical purposes, and which can sell potash at a price which will work no hardship on any users. It is my purpose in this paper to outline the sources from which it seems most promising to produce American potash.

The present methods employed for obtaining potash in this country may be grouped under four general heads.

1. By the evaporation of the brines from various lakes and marshes.

2. From kelp and the ashes of various plants.

3. As a by-product of various industries, chief of which are the cement, iron, beet sugar, and molasses industries.

4. By the decomposition of silicate rocks, chief of which are alunite, glauconite and feldspar. Numerous other silicates are also available, among which are leucite and sericite.

BRINES AND LAKES

It is natural that the first attempts to obtain potash in this country were connected with the evaporation of brines from various lakes in the western part of the country. Geological Survey reports, even before the war, had called attention to the large amount of potash contained in the waters of some of these lakes, notably Searles Lake, in Southeastern California, which has been made the subject of extensive investigations on the part of the United States Geological Survey. The American Trona Corporation was organized in 1913 to exploit this lake, and had planned to spend something like $3,000,000 to build a railroad and to install the

[1]A paper read at the Buffalo Meeting of the American Institute of Chemical Engineers, June 22, 1917.

necessary machinery to recover borax and potash from this water. At that time, particular stress was laid on the borax rather than on the potash.

Searles Lake is located in the extreme northwestern part of San Bernardino County in southeastern California about thirty miles from the Southern Pacific Railway, at Searles. It consists of a dry bed of crystalline salts, hard enough to support a wagon and team. It occupies an area of from eleven to twelve square miles and has a depth of approximately 70 ft. The deposit contains a saturated brine in the interstices between the crystals, estimated to be 25 per cent of the volume of the bed, and carrying approximately 2.1 per cent potash (equivalent to 4 per cent potassium chloride) and about 1.3 per cent borax. An analysis (W. Van Winkle) of the solid matter from the water is given below:

	Per cent
K	6.34
Na	33.80
Cl	37.04
SO_4	13.00
CO_2	7.24
B_4O_7	2.50
Other constituents	0.08

By reference to the analysis above, it will be seen that the principal products obtained are potassium chloride, borax, soda ash, salt, and sodium sulphate. Of these products the salt will be largely in excess of all others.

I understand that the American Trona Corporation has expended $2,500,000 to date in developing this property, of which $600,000 has been spent for the construction of a 30-mile railroad connecting the lake with Searles, on the Southern Pacific Railroad. The company has built two plants, one at Trona, where the brine is evaporated, and the other at San Pedro, Cal., where the solid salts obtained from the evaporation are separated.

The American Trona Corporation has shipped quite a large quantity of potash in the past year. I understand that from the chemical standpoint, an objection is raised to their product owing to the sulphates and borax which it contains, and I am also informed that the fertilizer people have objected to the product on account of the borax.

There are numerous small lakes in the region of the Sand Hills of Nebraska, the waters of which are more or less alkaline and also contain potash. This potash is believed to have resulted from the leaching of the ashes from numerous forest fires which have occurred in that section. The larger and deeper of these lakes are only slightly alkaline and the only ones which are at all rich in alkali are the small lakes.

The Potash Products Company, of Omaha, Neb., has been for some time a producer of potash which they obtain by evaporating the water from Jesse Lake, situated in this section. This lake covers 240 acres and is located 300 miles west of Omaha, and 3 miles from Hoffland. The lake is underlaid with a dark greenish-colored mud, beneath which is a sand bed 20 ft. thick, strongly impregnated with brine of greater concentration than the surface waters. This brine contains about 13 per cent solid matter, of which from 25 to 30 per cent is soluble K_2O. The Potash Products Company has a capacity of about 75 tons of dry salts daily, their product will probably average 28 per cent K_2O, so their total output is approximately 21 tons of K_2O per day. No attempt is made to separate potash from the other salts, and the material is shipped as evaporated. The potash is in the form of carbonate, and the product also contains a large quantity of the carbonate of soda.

Other small lakes are being developed by the Hord Alkali Products Company of Lakeside, Neb.

The officials of this company inform me that it owns about 50,000 acres of land in which these alkali lakes are located, but that their development work has been carried only a year in advance of their requirements. This company began construction of an evaporation plant about a year ago, and started operation Jan. 1, 1917. Their plant has a capacity of from 40 to 50 tons of product per day, working on brine of about 1.075 sp. gr. This brine is pumped from wells located in lakes, the surface water of which is comparatively fresh (containing less than 1 per cent of solids). The plant itself is located on the main line of the C. B. & Q. R. R. at Lakeside. It is equipped with triple effect evaporators for preliminary concentration, and single effect for the salting out. The concentrated salts are fused to a clinker in a small rotary kiln, ground in a Stedman disintegrator, and packed in sacks of approximately 200 lb. each. The product has the following general composition:

	Per Cent
Na_2O	33.30
K_2O	21.82
SO_3	16.98
Cl	4.22
CO_2	21.87
Loss on ignition	1.50
Insoluble in water	1.25
	100.94

This region is entered by the Chicago & Northwestern R. R. and by the Chicago, Burlington & Quincy R. R., so that the transportation facilities are excellent. Unfortunately the supply of brine in these lakes is very limited. It is estimated that Jesse Lake, the largest of them, contains approximately 28,000 tons of K_2O.

There are a number of other companies throughout the west who are experimenting on the production of potash from brines. One of these companies is the Inyo Development Company, who has a small experimental plant and are planning to develop the potash resources of Owens Lake.

Owens Lake is situated south of Mt. Whitney and northeast of Death Valley, Cal. The lake is 27 miles long and 23 miles wide, and is estimated (H. S. Gale) to contain 3,000,000 tons of potash. An analysis of this water is given below:

	Per Cent
NaCl	39.51
Na_2CO_3	41.34
$NaHCO_3$	4.41
K_2CO_3	2.21
Na_2SO_4	12.06
Other constituents	0.16

Several thousand tons of soda ash have been made at Owens Lake, and it is proposed to recover the potash

from the spent waters from the soda ash manufacture. These waters were formerly wasted and contained about 4.25 per cent K_2O in the form of carbonate.

Another lake which it is proposed to develop but towards which I believe no material steps have been taken at the present time—is Summer Lake, in Oregon. This is about 30 miles from Pleasant View, Ore. The water is very similar to that of Owens Lake as will be seen from the analysis below:

	Per Cent
NaCl	27.10
Na_2CO_3	43.91
$NaHCO_3$	21.41
KCO_3	3.63
Na_2SO_4	2.21
Other constituents	0.87

There has been some attempt to develop a potash industry in connection with the Great Salt Lake, in Utah. The Utah Chemical Company is reported to be erecting a plant to make potash from the bitterns obtained as a by-product from the manufacture of solar salts from the waters of the Great Salt Lake. This plant is largely an experimental one.

By referring to the above it will be seen that practically all of the above developments during normal times would be limited largely by the capacity of the plant to get rid of other products than potash. There is also the objection that none of these waters will yield potassium chloride without treatment with reagents. The Nebraska Lake propositions, which would promise most under normal conditions and which are reported at the present time to be making a large amount of money, are quite limited as to brine supply and unquestionably they could only furnish a very small part of the potash which has been shipped to us from Germany.

The developments at Searles, Owens and Summer Lakes will depend almost entirely on the Pacific Coast market for soda ash and salt cake, and it is hardly probable that under normal conditions the market in that section will be sufficient to dispose of any very considerable quantity of these products. In the case of both Owens Lake and Summer Lake, the quantity of soda to be disposed of is so very much larger than that of potash, that they probably would never amount to anything more than very small potash producers. Against Summer Lake is also the difficulty of transportation and of obtaining labor, and the high cost of fuel.

The nearest soda ash plant is at Hutchison, Kan., but it is probable that this latter plant would cut them off from any trade East of the Pacific states, so that their market for soda ash would be almost entirely confined by adverse freight rates to the Pacific Coast. Even when it came to shipping potash to the East, they would have a very considerable freight rate (about $6.00) to overcome.

KELP

The fact that the giant kelps of the Pacific Coast are rich in potash has long been known. As early as 1911, kelp was gathered and dried by the Pacific Mulch Company, Terminal Island, Cal., but no effort was made by this company to do anything more than harvest the kelp, partially dry it, and chop it into pieces from 6 in. to 8 in. long. In the 1913 *Mineral Resources* the United States Geological Survey reported that a number of companies had been formed to engage in the kelp industry. At that time, however, no effort was being made to extract potash salts from kelp, and attention was entirely devoted to the harvesting, drying and grinding of the kelp.

I believe that the American Potash Company was formed prior to the war and was the first company actively to attempt the production of potash from kelp. This concern had a plant at Long Beach, Cal., where they harvested and dried kelp, using an oil-heated rotary dryer for the latter purpose. Some dried kelp was sold as such, while the rest was burned in a reverberatory furnace, the potassium chloride and sodium chloride leached out of the ash, and separated from each other by fractional crystallization. The American Products Company, Pasadena, Cal., later bought the effects of the American Potash Company, and moved to the property of the latter. This new concern was said to be financed by Mr. George Simmons, of the Simmons Hardware Company, St. Louis, and it was reported that their main idea was to carry out a process worked out by Mr. Isaac Naylor, in which the kelp was to be so treated that a celluloid composition for knife handles, etc., would be the main product, and potash would be obtained as a by-product. Little information is available as to the operations of this company.

Swift & Company, of Chicago, leased a small plant at San Diego and are harvesting and drying kelp. They make no effort to extract the potash, but are simply drying the kelp and shipping it to their fertilizer factories in the East, where it is used in the manufacture of mixed fertilizers. This plant is interesting as it is said to represent the best methods yet tried for drying kelp mechanically. The old plant consisted of two rotary dryers, one 54 in. in diameter by 35 ft. long, and the other 60 in. in diameter by 40 ft. long. The wet material was fed into the cold end of the larger dryer, dropping out from the hot end, and was thence conducted by a belt conveyor into the hot end of the small dryer, leaving the latter at the cold end. The product, which contains 10 per cent water, is ground in a swing hammer mill, and sacked. The dry product contains the whole body of the kelp (including the nitrogen) and averages 15 per cent water-soluble K_2O. Swift & Company have now built a large plant containing ten direct heat dryers, 60 in. in diameter by 40 ft. long, employing crude oil for fuel. The buildings are of steel; electric drives and modern equipment are employed throughout. The plant is designed to treat 200 tons of wet or 20 tons of dry kelp per day.

The Hercules Powder Company have the only large plant on the Pacific Coast at the present time for actually obtaining potash salts from kelp. Their plant is located at Chula Vista, Cal., and represents a splendid example of chemical engineering ingenuity, although it is probably only a war-time proposition. The products obtained are potassium sulphate and acetone. The kelp is harvested by machinery and is ground by the harvesters to a thick, viscous mass. This latter is pumped into digestion tanks and fermented, whereby the slime and other organic matter form into acetic acid. This acetic acid is neutralized with calcium carbonate and converted into sodium acetate by sodium sulphate. This latter is a waste product from the ace-

tone plant. The liquid is then evaporated and the sodium acetate crystallized out. The potash is obtained 80 per cent pure, while the sodium acetate is recrystallized and then used in the manufacture of acetone. This plant is handling about 1500 tons of wet kelp per day, obtaining from this about 18 tons of potash and 24 tons of acetic acid. The process of clarification, sedimentation, etc., is very similar to that used in sugar manufacture.

The U. S. Department of Agriculture is now investigating with a full-sized plant the possibility of the destructive distillation of kelp. The products obtained are gas, tar, ammonia, iodine, charcoal and potash. The gas will be used to heat the retort, and the potash will be leached from the charcoal.

The possibilities of the production of potash salts from kelp on a large scale do not seem to be particularly bright as a post-wartime proposition. The artificial drying of the kelp represents a large undertaking, since 20 tons of potash require handling something like 1500 tons of wet kelp, containing 1350 tons of water. The plant required to conduct such a large drying operation is considerable, and the type of rotary dryers employed seldom show an efficiency of more than 70 lb. of water per gallon of oil burned, or about 38,000 gal. of oil for 1500 tons of kelp. The cost of this amount of fuel alone under ordinary conditions would eat up most of the price obtained for the product. With destructive distillation and the employment of the gas to help heat the retort some saving in fuel could be effected, but we doubt if this saving would prove very considerable. We also doubt the value of the charcoal. After the potash had been leached from it, this charcoal would unquestionably contain considerable water, and if it is anything like the similar residue obtained in the paper industry, no use could be found for any considerable quantity.

The manufacture of acetone from kelp is manifestly a war time industry, so that potash as a by-product from this industry is not likely to survive the need of acetone for making smokeless powder.

BY-PRODUCTS OF OTHER INDUSTRIES

It has long been known that potash was among the volatile products passing off in the waste gases from a number of furnaces, notably from the rotary cement kiln and from the blast furnace. The writer made some experiments as far back as 1903 at the plant of the Dexter Portland Cement Company, to determine the effect which the ash of the fuel had on the cement, and particularly the percentage of ash which entered the cement during burning. Among other things which were disclosed by this investigation, was the fact that there was a considerable proportion of both potash and soda volatilized in the rotary kiln. My investigations at that time were made on a 6-ft. x 60-ft. rotary, and I found that approximately 50 per cent of the potash and about 25 per cent of the soda was volatilized. The results of the writer's experiments were given in a paper read at a meeting of the American Association of Portland Cement Manufacturers, at Atlantic City, in the summer of 1904, and also in his work "Portland Cement."

About this time Professor Hillebrand, then of the U. S. Geological Survey, found that the raw material contained relatively much more potash than the cement, and he therefore assumed there must be some loss of potash in the burning of cement.

Mr. Clifford Richardson read a paper at the 1904 meeting of the American Society for Testing Materials, in which he proposed to the cement industry that they collect the potash lost by means of a water spray, and stated that Dr. Hillebrand had applied for a patent upon such a process. We believe, however, that no patent was ever granted. The matter was discussed informally, but it was generally conceded at that time that the cost of collecting this dust with the apparatus then known, namely, water sprays, would far exceed its value, if indeed it could be collected at all.

In southern California there had been considerable opposition from the orange growers to the cement plants owing to the dust which settled on the orange groves. It was claimed that this reduced the value of the fruit. Numerous suits were started, and in order to appease the orange growers the two plants near Riverside undertook to eliminate the dust. The California Portland Cement Company in 1911 installed a system of dry settling chambers followed by water scrubbers at their plant at Colton, and the Riverside Portland Cement Company in their plant near Riverside installed even prior to this a Cottrell electrical precipitation treater, which latter was then largely in the experimental stage. The Riverside people persisted, however, in the use of this treater, and gradually developed it into a very efficient method of catching the dust. By this means they were able to recover 95 per cent of the dust formerly lost from the kilns. It was found that in this dust was from 80 to 90 per cent of the potash volatilized in the kiln. Unfortunately, however, the raw materials at that time in use at Riverside were quite low in potash and the dust obtained from the last part of the treaters averaged only about 4 to 5 per cent potash and that from the first part materially less than this, practically all of which was soluble in water.

In order to obtain a material richer in potash all of this dust was fed to a supplementary kiln and was burned to cement in that kiln. From this kiln, dust was obtained running in excess of 30 per cent K_2O, but it was found that most of the potash in the dust fed into the kilns did not volatilize but remained with the clinker, due no doubt to the fact that the potash was present in the dust as sulphate.

When fertilizer companies began to purchase low-grade material for potash, one of the first substances which attracted their attention was the crust which collects on the side of the stacks of the rotary kiln, and which falls down at intervals into the dust chamber, its high potash content having been pointed out by the writer in the paper mentioned above and also in his work on Portland cement. They persuaded a number of the cement manufacturers to save this crust, which they purchased at prices ranging from $1.50 per unit in the early days of the war to $3 per unit later on. This dust averaged 6 to 8 per cent of water-soluble potash.

The Security Cement & Lime Company are among the cement companies who sold their flue dust. They were located near the heart of the fertilizer manufacturing district. Their manager, Mr. J. J. Porter, after seeing the installation of the Cottrell system at the first chemical show, was very much impressed with the possibility of catching all of the dust from the stacks. He re-

turned home and made investigations which demonstrated that they could expect to obtain quite a high percentage of potash in this dust. He then visited Riverside and investigated the process there, and as the result of his investigation persuaded his company to install the Cottrell process, not with a view of eliminating the dust—as they were meeting no trouble from this source—but with a view to catching the wasted potash. Their plant was put in operation in the summer of 1916. Numerous difficulties were encountered at the beginning, most of which have been satisfactorily eliminated.

One very peculiar situation presented itself which had not been foreseen. At the plant of the Riverside Portland Cement Company at Riverside, practically all of the potash in the dust was in the water-soluble condition. When the treaters were put in operation at Security, it was found that only a little more than half of the total potash in the dust was water-soluble, and that while the dust contained from 12 to 15 per cent total potash it contained only about 6 to 7½ per cent of water-soluble potash. The only explanation which could be offered to account for the difference in the state of the potash at the two plants is that at Security the cement is burned with pulverized coal and at Riverside with oil. It appears, therefore, that chemical combination takes place between the products of combustion and the potash.

It is found, however, that all of the potash in the dust may be dissolved by prolonging the digestion with the hot water and by digestion under high pressure. It is also readily soluble in acid. In making mixed fertilizers with this dust, it was found that a considerable portion of this potash was rendered soluble when the dust was mixed with acid phosphate.

It has, of course, been known that chlorides will increase the volatilization of potash. Numerous experiments were made at Security to increase the liberation of potash from the raw material and also to prevent its production in an insoluble form. One scheme was to inject sulphur dioxide into the kiln. The plan, however, which has proved most successful, is to introduce a small amount of salt with the raw material and also with pulverized coal. When the treater was first placed in operation the average water-soluble potash in the dust was about 6 per cent, but since the introduction of the salt the quantity has been increased to 8½ per cent. Patents have recently been granted to Huber and Reath (Nos. 1,194,344 and 1,219,315), who propose to use calcium fluoride in place of salt. They claim that the latter is entirely recovered by the treaters so that only a very small quantity of this mineral is needed, the original charge passing around in a cycle as it were. This process is in use at the Riverside plant, and it is claimed 90 per cent of the potash is volatilized where it is used.*

The installation at Security was followed by one at the Duluth plant of the Universal Portland Cement Company with a view of eliminating dust only. At this plant very little potash is obtained, and I believe no effort is made to market the dust. This is due to the fact that slag (which here takes the place of the clay element of the cement mixture) contains practically no potash.

*This process has been fully discussed in this journal, Vol. XVI, June 15, 1917, page 701.

At the Alpha Portland Cement Company the waste gases from the kilns are first led through water-tube boilers and thence into Cottrell treaters. At this plant the percentage of potash in the dust is very low, containing about 8 per cent total potash, while only about 2½ per cent of this is water-soluble. It was found that the percentage of water-soluble potash was increased very largely by the use of salt, but, unfortunately, this salt collected on the tubes of the boilers and interfered with the steaming properties of the latter, so that this addition is no longer made at this plant.

The Santa Cruz Portland Cement Company, Santa Cruz, Cal., have been experimenting for the past ten months with one of their kilns, and have been making nearly 700 lb. per day of potassium sulphate, 80 to 90 per cent K_2SO_4. The details of their process are not now for publication, but they do not employ the Cottrell dust precipitation system. They state that they consider their process a success and propose shortly to install their system on all their kilns.

At the present time installations of the Cottrell system are being made at quite a number of plants with a view of obtaining a dust high in potash which can be sold to the fertilizer trade.

The soda as well as the potash is volatilized to some extent, so that the dust will contain some water-soluble soda. Usually the proportions are about 1 to 4 or 1 to 3. When salt is used in the raw materials the proportions are much smaller.

As we said in the earlier part of this paper that practically all the potash in this dust could be slowly extracted with water, it is highly probably that *all* of the potash in this material is available for plant food. In addition to the potash this material is rich in lime, therefore we have in this one material two very valuable fertilizer ingredients—lime and potash.

At the present time the fertilizer men are perfectly willing to take this dust carrying as low as 4 per cent K_2O, but it is extremely doubtful if they will accept it after the war is over and they can get German potash. The objections to the dust are twofold: First, it is of course highly alkaline, containing both calcium carbonate and oxide. When used in mixed fertilizers in large quantity the lime reverts the phosphoric acid to the insoluble form. Second, the dust is too low in potash to permit using it in fertilizers to contain more than 2 per cent K_2O. Two alternatives suggest themselves—one to educate the farmer to the use of this material *as such*, and the other to extract the potash by leaching and evaporation and market the salt as chloride or sulphate. The latter method has been worked out by Messrs. Huber and Reath at the Riverside Portland cement plant, and is described in the reference given above.

In addition to the experiments mentioned above, the writer has been able to examine samples of raw materials and clinker from some half dozen different plants since the European war. All of these samples show a loss of potash ranging from 1¾ lb. to 2½ lb. per barrel of cement burned, an average of about 2 lb. per barrel. It should be remembered that not all the potash so obtained, however, is water-soluble, but it is all available for plant food, and undoubtedly methods of leaching out the same can be easily worked out if found necessary. The efficiency of a Cottrell treater will range between 95 and 98 per cent of the dust and 80 to 90 per

cent of the potash. When no treaters are installed the dust losses range from 3 to 5 per cent of the raw material introduced into the kiln.

At the present time the loss of dust at the average cement plant is probably in the neighborhood of 3 per cent, or 18 lb. of dust per barrel of cement. If 95 per cent of this dust and 80 per cent of the potash were recovered, dust would be obtained having approximately 9 per cent potash. Assuming that there could be recovered 1.6 lb. of potash per barrel of cement there would be produced from the cement industry alone 72,000 tons of potash (figured as K_2O) per year, or nearly one-third of the before-the-war importations from Germany.

The Bureau of Soils, Department of Agriculture, is at the present time preparing a very extensive report on the potash possibilities of the cement industry, and this report covers the subject of the losses of potash at various plants very completely.

About the time of the beginning of the European war, I made a number of experiments in a small kiln, 2 ft. in diameter x 20 ft. long, to ascertain the possibilities of obtaining potash as a by-product from the cement industry, using feldspar, limestone and iron ore as the raw materials. If iron ore is not used, white cement would be obtained, but it was our idea to come as near as possible to producing the product of most of the cement mills.

These experiments followed two general lines. At first we furnaced at about 800 deg. C. a mixture containing salt or calcium chloride and lower in lime than would be used for cement, leached the resulting soft brown clinker with hot water to extract the potash, mixed sufficient limestone with the residue to make a proper cement, ground, and burned the mixture to cement. The second line of experiments consisted in making up a proper mixture for cement and burning it directly to cement, volatilizing the potash in so doing. We met with a fair degree of success along the second line. With the first process a number of difficulties were encountered. One was that with the best treatment we could give we could not render soluble more than about 60 per cent of the total potash in the feldspar, and that we lost some by volatilization. We found on analyzing the commercial side of the case that it seemed to be a much better proposition to attempt to volatilize all of the potash and make a cement clinker at one operation, particularly as we were able to volatilize about 70 per cent of the total potash, whereas we were never able to render more than 60 per cent of it soluble in the two-stage process. Furthermore, it required very little additional fuel to produce a cement than it did to produce the lighter burned material, and with the latter there was of course the extra fuel needed to burn it to cement. Owing to the large amount of water in the leached material this latter operation required more fuel than would be required to manufacture cement in the first place. To render the potash soluble we also had to use a considerable portion of either salt or calcium chloride, whereas if volatilized we used only a very small quantity. As an example of what we did along the line of volatilizing the potash take the following example: A mixture was made up of three raw materials, limestone, feldspar, and iron ore of the following composition:

	Limestone Per Cent	Feldspar Per Cent	Iron Ore Per Cent	Mix Per Cent	Cement Per Cent
SiO_2 ...	1.02	68.12	16.20	13.40	20.80
Al_2O_3 ...	0.40	19.05	1.88	3.78	5.86
Fe_2O_3 ...	0.42	1.15	71.98	1.98	3.07
CaO ...	52.20	0.51	0.25	41.77	64.60
MgO ...	1.51	0.47	1.65	1.25	1.94
K_2O	0.21	8.52	0.25	1.69	0.80
SO_3	...	...	...	...	1.65

These three materials were mixed in the following proportions:

Limestone	800 lb.
Feldspar	180 lb.
Iron ore	20 lb.

These gave a mixture of the analysis shown in the fourth column, and the final cement had the analysis shown in the fifth column.

This cement was found to have excellent physical properties and to compare favorably with any cement at the present time on the market. It was normal in every respect and would have been accepted by any engineer as first-class material.

By referring to the analysis it will be seen that the raw mixture contained 1.69 per cent of potash. As it takes 600 lb. of raw material to make a barrel (400 lb.) of cement, there were charged into the kiln 10.14 lb. of potash for each barrel of cement produced. As the clinker contained 0.80 per cent potash, there was in each barrel of cement 3.20 lb. of potash, making a loss by volatilization of 6.94 lb. per barrel. Assuming a dust loss of 3 per cent or 18 lb. per barrel, this dust should contain 38.56 per cent K_2O.

The potash volatilized at various plants, as I have said, varies quite widely, ranging from 1.5 to 2.5 lb. At plants where the former amount is lost, recovery would probably give a dust too low in potash for sale in this form. At such plants recovery would have to be followed by leaching. Experiments which we have made convince us that this can be successfully done if proper means are installed. This would give a dust which could be used in the kilns and the potash would be in the form of a salt running 60 per cent to 80 per cent K_2SO_4.

It should also be borne in mind that there is always the possibility of increasing the liberation of potash by selecting raw materials high in potash. No doubt in many localities a change of clays from one low in potash to one higher would bring about the desired result. In many localities feldspar and sericite are available and might be mixed with the clay without detriment to the cement. Indeed, as I have indicated above, feldspar and iron ore might take the place of clay, or, if a white cement is desired, feldspar alone might be used. At the Riverside plant, feldspar is mixed with the shale to increase the potash in the raw material burned.

The possibilities of developing a paying potash industry in connection with the manufacture of cement are excellent. Unfortunately for the speedy establishment of such an industry, the very high cost of steel plate and structural steel at the present time will undoubtedly keep many manufacturers from installing plants who would otherwise do so. The question, too, is not alone one of price, but also of deliveries. No

manufacturer would care to pay the present high price of steel without assurance that he would also enjoy the present high price for potash. Under normal conditions a treater plant for precipitating the dust from a 3000-bbl.-per-day cement mill will cost about $190,000 complete, or 10 cents per barrel of annual output, but at the present time the cost will be fully twice this amount.

The dust question has always been one of more or less annoyance. The chance to settle this thing once for all and at the same time obtain a valuable product will certainly appeal to the cement industry. In addition to the Cottrell treaters, I believe that most manufacturers will also install boilers after their kilns to save the waste heat from the latter, which is normally more valuable than the potash. The two installations work very nicely together, as the flues, dampers, fans, etc., of one installation will serve for the other, and the boilers will cool the gases enough to permit the use of very much smaller treaters, since the size of the treaters required is proportional to the volume of gases to be cleaned. The normal cost of boilers and treaters will be about 15 to 18 cents per barrel of annual output, but from 30 to 35 cents per barrel at present prices.

If many cement manufacturers would install boilers and treaters now, even with the present high cost of materials, and could sell their potash for $3 per unit for one year, they could pay for their plants.

I estimate that it would cost at present prices approximately $30,000,000 to equip all the cement plants in this country (where such installations would pay) with boilers and treaters, and that for this outlay we would save annually, even in normal times:

72,000 tons of K_2O at $80 per ton.....	$5,760,000.00
2,400,000 tons of coal at $3 per ton.....	7,200,000.00
Total saving.....	$12,860,000.00

Even after deducting the cost of operation, upkeep, etc., this would pay a very handsome interest on the investment.

The loss of alkalies in the blast furnace has been known for many years, but no efforts had been made to recover potash up to the outbreak of the war. Mr. R. J. Wysor, then chief chemist but now superintendent of blast furnaces of the Bethlehem Steel Company, had analyzed the dust from the bottom of the stove checkerwork and found it to contain 15 per cent of water-soluble K_2O. Attempts to sell this material prior to the war failed, but with the demand induced by the war it was found readily salable and has been collected and sold ever since.

Mr. Wysor has since that time made a very extensive study of the possibilities of potash recovery from the blast furnace gases at Bethlehem. The result of his investigation is given in a paper read at the February meeting of the American Institute of Mining Engineers in New York, abstracted in our issue of Feb. 15, 1917, Vol. XVI, page 205, and most of the information given below is taken from his paper.

The ores used by the majority of iron manufacturers range from 0.21 to 0.33 per cent K_2O. Some of the Southern iron ores contain much more, but generally speaking these are high in clay and hence would naturally contain feldspar. Coke generally contains about 0.25 per cent K_2O, and limestone varies from 0.1 to nearly 1.0 per cent K_2O. The impure limestones high in clayey matter usually contain most K_2O, and dolomites, generally speaking, are higher in K_2O than are calcites.

Wysor found in the Bethlehem charge 32 lb. of potash per ton of pig iron produced, of which about half came from the ore and a quarter each from the limestone and coke. He found that 20 per cent of the potash remained in the slag, and hence 80 per cent was volatilized, of which the wet scrubbers remove 58 per cent, it going into solution in the water used to wash the gases. The solution is too dilute, however, to permit of the recovery of the potash by evaporation. Wysor estimates that it is possible to recover about half of the total vaporized potash by dry cleaning the gases, using a Cottrell treater instead of the wet washers. Up to the present time only about 4 per cent of the total potash has been recovered and sold, yet the amount of dust so recovered in fifteen months has amounted to 106.3 net tons of K_2O. It represents only the dust most easily collected at the stoves, boiler flues, and dust catcher. This dust averages about 9.9 per cent water-soluble potash. The dust, unlike that from the cement industry, is not highly alkaline. It is probable that after the war leaching would have to be resorted to.

As in the cement industry, certain advantages other than the recovery and sale of the product are connected with the removal of the dust from the gases, notably the better cleaning of the gases. It seems very probable that the dry method of cleaning will replace the wet method at many furnaces. This would result in the saving of much potash. Assuming a recovery of 10 lb. of potash per ton of pig iron, and an annual production of 25,000,000 tons of pig iron, the annual potash resources of the iron industry would be 125,000 tons of potash, figured as K_2O.

Our former imports from Germany averaged about 250,000 tons of K_2O annually, so it will be seen that the cement industry and the iron industry alone might be developed to produce nearly 200,000 tons annually.

The cost of operation of the dry treaters would probably prove less than that of the wet washers now used for cleaning blast-furnace gases, so that the only added cost of potash recovery would be the labor of collecting the dust, leaching, etc., and the fuel for evaporation of the liquid and for drying the salt, which items would be about the same as for cement-kiln dust.

The production of potash from the waste liquor of beet sugar manufacture, molasses, etc., has been treated of in a paper which has been read at the Buffalo meeting of the American Institute of Chemical Engineers, June 22, 1917, and published in Metallurgical and Chemical Engineering, Vol XVII, July 1, 1917, page 17, so that it is hardly necessary for me to go into this subject at this time. It is estimated that about 2000 tons of potash (figured at K_2O) are now being produced annually from this source, one of the largest producers being the Western Alcohol Products Company of Agnew, Cal., and it is said that their output is larger than that of any of the kelp plants on the Pacific Coast.

POTASH FROM SILICATE ROCKS

The production of potash from silicate rocks has been the subject of much chemical investigation, and the patent offices of England, Germany and the United States have granted many patents on processes looking

toward this end. One of the oldest of these was granted to F. O. Ward and F. Wynants (English patent No. 3185) in 1857. This process is said to have been tested at that time on a large scale and to have given satisfactory results. It consisted in finely grinding and mixing feldspar, flourspar, and chalk, and after molding the mixture into balls or cakes, heating them to a yellowish red heat. A porous clinker was obtained which on leaching with hot water gave up its alkali. It is interesting to note that Ward, even at that time, proposed to use the residue from which he had leached the potash for the manufacture of hydraulic cement.

It is quite natural that the chemical principles made use of by Prof. Lawrence Smith to attack silicates in his method for determining the alkalies, should have been the subject of much investigation looking toward their application to the liberation of potash from feldspar and other silicates on a large scale; and many patents have been granted making use of the essentials of his methods, but varying the reagents and procedure so as to apply more directly to practical work.

One of the earliest of these patents was that granted to Rodin (U. S. No. 641,406). He used a mixture of powdered feldspar, salt, and lime. This patent has been followed by a large number of others granted for various modifications of the same general scheme in which gypsum, calcium chloride, and other haloid compounds took the place of the salt. Nearly all of these processes make use of lime in connection with the above reagents.

Along a somewhat different line we have another series of patents, the first of which was issued to A. J. Swayze in 1905 (No. 862,676). He proposed to fuse feldspar, gypsum, coal, or coke, in a blast furnace, whereby potassium sulphates would be volatilized. Other patents along this line are those issued to H. E. Brown (U. S. Nos. 1,123,841, 1,123,864 and 1,124,238). Just recently there are a whole series of patents issued to A. C. Spencer and to Spencer and E. C. Eckel, covering the volatilization of potash and the production of hydraulic cements (U. S. Nos. 1,209,220, 1,209,219 and 1,209,135).

In addition to the above general line of patents we have many in which novel methods of attack have been proposed, and in which various valuable by-products would be obtained which would assist in paying for the process.

It has generally been conceded that to make potash from feldspar alone was an almost impossible undertaking under normal conditions and pre-wartime prices for potash. The reason for this may be readily understood when we take into consideration that feldspar as ordinarily mined, without careful sorting and selection, very seldom runs over 10 per cent potash and frequently as low as 8 per cent. At a price of 80 cents a unit, this would allow only $6.40 to $8 for the mining or quarrying of the feldspar, its crushing and grinding, the reagents which are to be used with it and the fuel and labor necessary to liberate the potash. In view of the fact that it is generally conceded that feldpsar mining will cost approximately $2 per ton, we have only $4.40 to $6 left to carry on the rest of the process and to furnish overhead and profits.

A very much cheaper source of potash than feldspar is the green sand or glauconite of the Atlantic Coastal Plain. The deposits of this mineral are very extensive and the quantity obtainable is probably greater than that of any potash mineral. My own observations of the New Jersey field has convinced me that green sand can be found in many localities in New Jersey containing as much as 6 per cent potash. These beds range from a few feet to 20 ft. in thickness. They are covered with very little overburden and the material can be dug with a steam shovel just as cheaply as sand can be obtained. I estimate that 10 cents per ton will cover both the stripping and the digging of the green sand. In addition to this, there are extensive deposits of lime-sand or marl adjacent to the green sand beds. These latter contain about 75 to 85 per cent carbonate of lime, and about 0.5 potash. In many instances the lime-sand overlies the green sand. These deposits are also located in a region where fuel is fairly cheap, where transportation facilities are of the very best, and where labor and living conditions are good. In view of these facts, it seems to be much more probable that potash can be produced directly from green sand at a profit rather than from feldspar.

Alunite has been largely exploited as a source of potash and is being used for that purpose now. It is, however, found as yet only in Utah. This deposit is comparatively small and is largely under control of a few people. It seems hardly probable, in view of the slow progress which has been made to date, that this will ever be the source of anything more than a local potash industry.

This applies to most of the other silicates, such as leucite and cerisite, all of which can be treated along the lines of attack proposed for feldspar and glauconite.

Considerable experimental work, some of it on a large scale, has been done on those processes in which lime and a chloride are mixed with feldspar or green sand and the mixture ground, furnaced, leached, and the resulting liquor evaporated. Mr. W. H. Ross of the Bureau of Soils published a very interesting paper along this line in 1912, giving the results which he was able to obtain by heating together a mixture of feldspar, limestone and either calcium chloride or salt. He found that unless he used quite a large proportion of lime and chloride that his yields were low. His best results being obtained on a mixture of one part feldspar, three parts limestone and one-half part calcium chloride, under which condition he obtained a yield of almost 95 per cent. But with a mixture of one part feldspar, one part lime and one-quarter part calcium chloride, he obtained a yield of only 60 per cent. Substituting salt for calcium chloride in the latter mixture, however, he obtained a yield of 68½ per cent.

Following along practically the same lines, and using a mixture of one part feldspar, one part calcium carbonate, and one-quarter part calcium chloride, and heating this mixture in a rotary kiln 2 ft. in diameter and 20 ft. long, I obtained a yield of 55 per cent potash. By substituting salt in place of the calcium chloride a slightly better yield was obtained. As the amount of lime was decreased from the above formula less potash was obtained. The more finely the mixture was ground the better results were obtained, but the best yield I could get with feldspar, lime and salt in the proportions given above was 73 per cent when the mixture was ground to a fineness of 98 per cent passing the 100-mesh sieve and 86 per cent passing the 200-mesh sieve. This was considered about the limit of economical grinding.

Substituting sericite for feldspar I obtained practically the same yield, but with glauconite I was able to obtain a much higher yield—in fact, all investigations which I have made lead me to believe that this mineral is very much more easily attacked than feldspar. With the glauconite-lime-salt mixture referred to above we have obtained yields as high as 85 per cent of the potash theoretically possible.

This is a very easy process to carry out. The operation of crushing and grinding the material have been well developed, and the furnacing can, of course, be done in a rotary kiln. No complications are experienced in this latter operation. The required temperature is low, and either producer gas, pulverized coal or fuel oil could be used. In my experiments I used the latter fuel for convenience. I do not believe any complication would arise from the use, however, of pulverized coal, and certainly not from producer gas. The material furnaces easily at temperatures varying from 800 to 1000 deg. C., depending on the composition of the mixture. No fusion takes place, the effort being made to produce a soft, porous clinker. This leaches easily without grinding, and 95 per cent of the soluble potash in it can be extracted with water. The amount of fuel required in the kiln is much lower than that required for the manufacture of cement, and certainly should not exceed for the dry process 250 lb. to the ton, and for the wet process 350 lb. to the ton. Any loss by volatilization can be taken care of by Cottrell treaters.

By leaching in series very strong solutions can be obtained so that the amount of water to be evaporated is cut down to a minimum. Potassium chloride can be easily separated from either calcium chloride or sodium chloride, and the latter can be returned to the kilns with the next charge.

On the other hand, if the sulphates are used, a difficult separation nearly always results. While there is probably less volatilization with the sulphates, there is much more difficulty experienced in obtaining a pure potash salt and, as it is well known, the chloride is the most acceptable salt for fertilizer manufacture.

Strange to say, very few attempts have been made to produce potash commercially by this process—possibly because it has not promised anything like the returns offered by some of those other processes in which by-products are obtained.

The Atlantic Potash Company recently bought out the plant of the old Northampton Cement Company at Stockertown, Pa., which had been standing idle for some time. They are operating under the patents granted to George F. von Kolintz (No. 1,201,396). This process consists in oxidizing the green sand and heating the same with calcium chloride without the use of lime. This plant is now in operation, and we understand that some potash has been produced.

Another method of liberating potash is covered by patents to S. Peacock, and consists in heating the finely ground mineral with lime under pressure in an autoclave, whereby the potash is made soluble and is leached out. The Waverly Chemical Company, Camden, N. J., has operated under Dr. Peacock's supervision, using green sand. They made some potassium carbonate which was sold to glass makers, but their operations have now been discontinued, presumably because they could not be conducted at a profit.

The Kaolin Products Company, Jones Point, N. Y., is using this same process in a small way, employing feldspar. They make a species of sand-lime brick from the residue. This brick, I am informed, is a very superior article.

Furman Thompson proposed to employ acid sulphate of soda and salt to attack feldspar (U. S. patent No. 995,105, and also No. 1,091,034, to H. P. Basset). Muriatic acid and salt cake are obtained as by-products. The Spar Chemical Company, Baltimore, Md., built a plant at Curtis Bay, Md., prior to the war, to produce potash by this method, but their efforts here failed, due largely to the difficulty of separating the sulphate of soda and potash.

Along the second line of patents referred to above (in which the potash is volatilized), we have the three granted to H. G. Brown, and covering the manufacture of potash and slag cement from feldspar. Brown proposes to fuse together limestone, feldspar and calcium chloride in a metallurgical furnace heated with coke. The potassium chloride is given off as a fume, which is to be collected by a Cottrell treater. The slag, which is tapped off, is to be mixed with slaked lime and ground into slag cement. The Buffalo Potash & Cement Corporation will operate this process. They have purchased the plant of the Niagara Cement Company in Buffalo, and expect soon to be ready to operate.

We also note in recent literature the organization of the Canadian Potash Corporation, which proposes to manufacture potash and cement along somewhat similar lines. They have purchased a crushing plant at Gravenhurst, Ont., where there is said to be a large feldspar deposit, and also a cement plant at Durham, Ont.

While we are disposed to criticise the cement end of these propositions so far as they anticipate making slag cement, the potash end looks entirely feasible, and if it can be operated independently of the slag cement production, it may be developed to any extent desired. Slag cement at the present time is not a very salable product, and we believe that practically all of those who first undertook its manufacture in this country have now abandoned it.

We now come to a series of patents most of which are dependent on some valuable by-product for their success with normal markets. For instance, we have the patent of Hart, in which barium carbonate, carbon and feldspar are heated together, and barium sulphate or other barium salts are obtained as by-products. The application of this patent is, of course, limited to the market for barium compounds. There are also a large number of patents in which aluminum salts are obtained as by-products. As there is about twice as much alumina as potash in feldspar, as ordinarily mixed, there would, of course, be a very large tonnage of alum or alumina to get rid of.

For instance, feldspar may average 20 per cent alumina and 10 per cent potash; therefore, for every ton of potassium chloride produced there would be possible 4¼ tons of dried aluminum sulphate, or 8¼ tons of dried alum. The amount of potash used in this country far exceeds the alum. If we consider the aluminum in feldspar on the basis of bauxite—the raw material for aluminum as well as alum, and of which the domestic production is about 225,000 tons annually—we can arrive at a better estimate as to the limitations of this field. Bauxite averages about 57 per cent

alumina, then the above amount is equivalent to 128,250 tons of alumina, which would take care of about 102,000 tons of potassium chloride or approximately 64,000 tons of potash.

I am informed that one experimenter is making brick of the residue from his leachings. This, of course, like the cement field, opens up a large market for the so-called by-product, especially since the brick is said to be of the highest quality.

In many of the processes proposed the quantity of potash is very negligible compared with that of the by-product, and under normal conditions its value is generally much less, so that with most of them potash is really the by-product and the other constituent the main one.

Summing up the situation, I believe that the largest future source of cheap potash available in this country is in the iron industry and the cement industry. Germany is reported to have $150 invested in her potash mines and equipment for every ton of potash produced annually. On this basis $37,000,000 would be needed to produce the 250,000 tons of potash imported into this country.

I believe that the expenditure of this amount of money in this country in these two industries alone would result in the recovery of potash now lost amounting to nearly 200,000 tons.

The balance could easily be obtained from the evaporation of lakes and brines, from beet sugar waste and from some of the processes now proposed for the manufacture of potash direct from feldspar or glauconite.

What is needed in this country to develop a potash industry is not research alone, but the feeling that when this industry is built up proper legislation will be enacted to prevent its being tumbled down by cut-throat methods from the foreign producer. While this might result in slightly higher-priced potash to the farmer, I fully believe that he will be justified in paying the higher price in order to be free from foreign dictation.

Baltimore, Maryland.

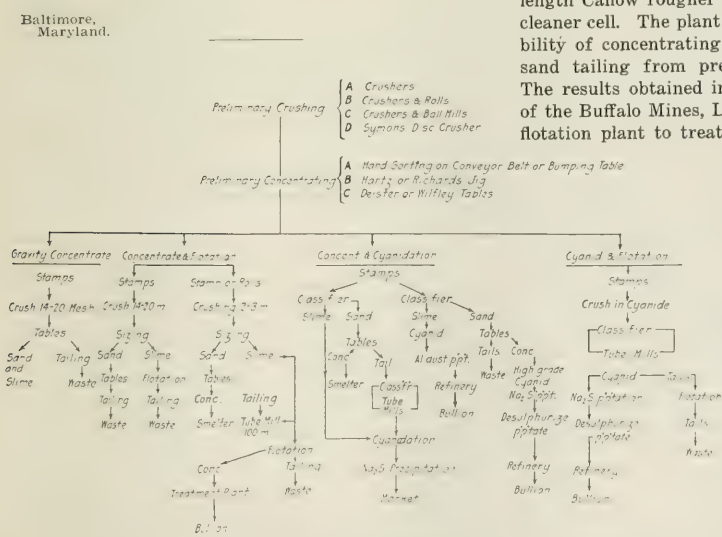


FIG. 1—MILLING PRACTICE COMPARISON IN COBALT DISTRICT.

Synopsis of Recent Metallurgical and Chemical Literature

Flotation

Present Flotation Practice on Cobalt Ores.—In the June, 1917, bulletin of the Canadian Mining Institute, pp. 544 to 553, is an article of considerable interest by J. M. CALLOW and E. B. THORNHILL on flotation as practised on cobalt ores. Flotation on a comparative commercial scale was first tried out by an experimental

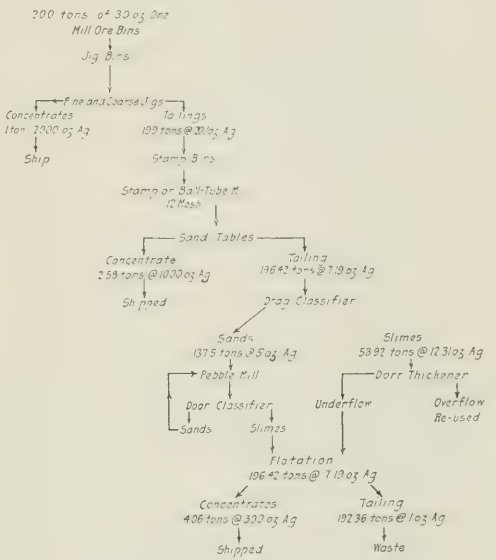


FIG. 2—COMPLETE MILL FLOW SHEET.

plant built and operated by the Buffalo Mines, Limited. This plant consisted of a two-compartment standard length Callow rougher cell and one one-half size Callow cleaner cell. The plant was built to determine the feasibility of concentrating the silver values in the stacked sand tailing from previous concentrating operations. The results obtained in this plant led the management of the Buffalo Mines, Limited, to erect a 600-ton Callow flotation plant to treat these tailings. This plant was put in operation in September, 1916. The McKinley-Darragh-Savage Mines soon followed with a second plant, of 200 tons daily capacity, and at the present time the Nipissing Mines, the Coniagas Mines, the Dominion Reduction Co., the Northern Customs Concentrators, and the National Mine, use the Callow pneumatic system of flotation.

Fig. 1 shows the milling practice at the different mills in Cobalt district at the present time. The flotation process has not replaced the standard method of gravity concentration, but its particular function is to save

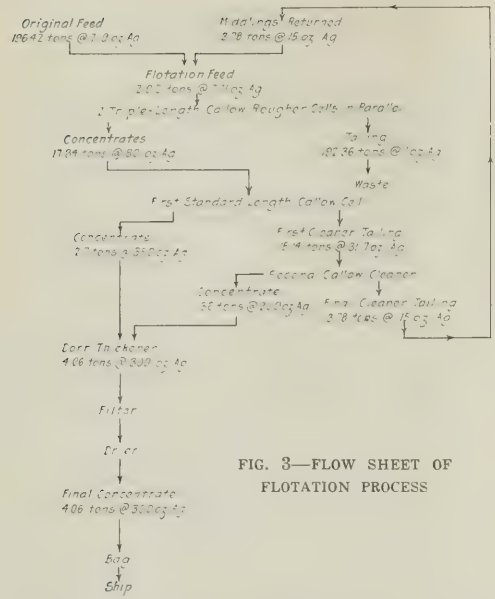


FIG. 3—FLOW SHEET OF FLOTATION PROCESS

the more friable silver minerals and fine leaf silver escaping from the gravity concentration. Fig. 2 shows the disposition of the flotation plant, and Fig. 3 indicates the treatment of the ore in the flotation plant proper.

The ore must be comparatively fine ground to liberate the contained values. The economic limit of grinding appears to be reached when not more than 1 per cent to 2 per cent is retained on a 100-mesh screen. Practically all the plants use mixtures of pine oil, coal-tar creosote, and coal tar; 15 per cent pine oil, 75 per cent coal-tar creosote, and 10 per cent coal tar gives an efficient mixture. At times, a mixture of 10 per cent pine oil and 90 per cent sulphur fuel oils gives satisfactory results.

The recovery of values by means of flotation varies over a wide range depending mainly on the product going to flotation, the grade of concentrate required and the experience of the operator. The most important item is the last one mentioned as it requires considerable time to produce an efficient operator. The average efficiency in flotation at the McKinley-Darragh-Savage Mines, Limited, is 82 per cent. The average headings at this mill runs 6.37 oz. and the tailing 1.14 oz. of silver.

With the exception of the Buffalo Mines, Limited, the companies producing flotation concentrates depend on the smelters in the United States for the disposal of their products and the schedules offered are not especially attractive. A representative schedule stipulates a $12 to $14 treatment charge per ton and payment on New York quotation of 95 per cent of the silver content. With silver selling at 70 cents an ounce the marketing cost per ton on a 300-ounce concentrate would be as follows:

Silver loss 5 per cent (15 ounces at $0.70)	$10.50
Treatment	14.00
Freight	11.32
Representation at the smelter	.50
Bagging and miscellaneous	2.00
Total marketing value for one ton of concentrates	$38.32

This high marketing charge has led to much investigation on part of the companies to devise suitable means for treating their concentrates locally. Cyanidation, desulphurization followed by cyanidation and oxidizing roasting followed by cyanidation of the roasted product gave no promises of economical results. A chloridizing roast followed by leaching, either with cyanide or an acid-brine solution has given the most satisfactory results. The Buffalo Mines is now treating 5 to 6 tons of flotation concentrates daily by this method, and claim a 95 per cent to 98 per cent extraction of the silver values. At this mill the chloridized product is first leached with an acid-leach to extract the base metals and then by a cyanide leach to recover the silver chloride.

Flotation has been adopted very rapidly throughout the district and to date only 790 tons per day of current tailings are not being treated by flotation. There are approximately 2,500,000 tons of impounded tailing in the district averaging 4 to 6 ounces of silver per ton that can be recovered by flotation at a substantial profit. As the ores of the district become lower in value flotation will of necessity become increasingly more important due to the cheapness of the process.

Gold and Silver

Flotation Tests on a Transvaal Gold Ore. F. Wartenweiler, in the Journal of the Chemical, Metallurgical and Mining Society of South Africa, November, 1916, pp. 87 to 90, gives a very interesting comparison of different treatments of a gold ore from the Transvaal. The best extraction was obtained by flotation.

The ore treated was an arsenopyritic gold ore. Grinding this ore to 150 mesh and cyaniding gave a maximum extraction of 45 per cent. By preliminary treatment of the ore with sodium carbonate or sodium hydrate, this recovery may be increased from 3 to 5 per cent. Recovery by amalgamation was so low as to be negligible. Sweet roasting followed by cyaniding gave the following results: The ore was crushed through 20 mesh, and contained 14 dwt. of gold. After roasting, the ore contained 95 per cent of the original gold, the loss being due to volatilization. The gold content of the ore ready for cyanidation was 13.75 dwt., of which 11.95 dwt. were extracted. The balance of gold was in the residue left after treatment with cyanide. The extraction amounted to 86.9 per cent. The net extraction, therefore, amounted to 86.9 per cent of 95 per cent, or 82.5 per cent. The low extraction, combined with high operating costs due to local conditions, would make the roasting operation prohibitive. Trials with gravity concentration and cyanidation gave a total extraction of 70 per cent.

Flotation tests with various oils, and in neutral, alkaline and acid circuits, were carried on, using 500-gm. samples. The coarse sulphide, which was only a small amount of the total, was recovered by panning, and added to the flotation concentrates.

The ore was ground in water to 90 mesh. It was kept submerged so as to prevent serious oxidation. It was pulped in water in a ratio of 5 to 1 with wood creosote and paraffine oil. Lime in solution was added until the alkalinity was 0.005 per cent CaO. The froth produced during the operation was withdrawn continually. After 15 minutes the dark, persistent froth of fine mineral floccules gradually changed to a froth of lighter

color, showing that gangue was being floated. At this stage the machine was stopped and the tailings discharged, in order to study the products. In general, the skimming of the froth was continued until no more mineral matter could be observed. This procedure naturally contaminated the concentrates, necessitating a further cleaning of the product, which was done by passing the initial concentrates through the machine a second time. The products of the second treatment were concentrates and middlings; in practice, the latter would usually be returned to the head of the roughing machine.

The following table will prove of interest, and needs no further explanation:

Product	Per Cent Weight	Assay, Dwt. per Ton	Value per Ton Original Ore, Dwt.	Per Cent of Total Gold Value
Concentrate..	14.7	67.0	9 85	71.1
Middling	12.5	8.7	1 09	7 9
Tail	72.8	4.0	2 91	21 0
	100 0		13 85	100 0

The middlings and tailings were treated by direct cyanidation with air agitation. The concentrate was roasted, then amalgamated and cyanided, the results obtained being illustrated in the following table:

Product and Assay	Treatment	Assay of Residue, Dwt	Extraction, Per Cent	Extraction of Total Value of Ore
Roasted concentrate 30.2 dwt.	Amalgamation and Cyaniding	6 9	94 3	65 0
Middling, 8.7 dwt...	Cyaniding	1.7	80 4	6 1
Tail, 4.0 dwt.....	Cyaniding	1.0	75.0	15.7
Total				87.1

The calculated value of the total residue was 1.78 dwt.

As earlier results with raw sulphide ore gave negative results with cyanidation, the concentrated material was not treated in the raw state. There was practically no premature precipitation of gold by residual carbon from flotation oil ignited during roasting. This matter was determined by treatment of the cyanide residue with sodium sulphide.

The most striking feature of the tests made is the comparative ease with which the gold is dissolved from the middlings and tailings. This emphasizes the extent to which the refractory material is transferred to the concentrates. In practice, it is advisable to assume a 5 per cent loss of gold, due to volatilization during roasting. This loss is 5 per cent of 71.1 per cent, or 3.55 per cent of the original ore. The total extraction is, therefore, 87.1 per cent of 96.45 per cent, or 84.05 per cent.

Copper, Lead and Zinc

Ore Treatment at the Falcon Mine, Rhodesia, South Africa. An article in the *South African Mining Journal*, Dec. 30, 1916, p. 421, by H. R. ADAM, gives a lengthy description of the metallurgical practice at this mine, which is situated at Umvuma, about 160 miles from Bulawayo. The most convenient method of illustrating the practice is by means of flow sheets, but before passing to these it may prove of interest to know that this mine has operated for the past two years, the monthly output being approximately 600,000 lb. of copper, 3000 oz. of gold, and 6000 oz. of silver; 18,000 to 20,000 tons of ore are treated per month, of which 14,000 to 15,000 tons are sulphides and the rest oxides. The sulphide ores contain 2.5 per cent copper as chalcopyrite and 5

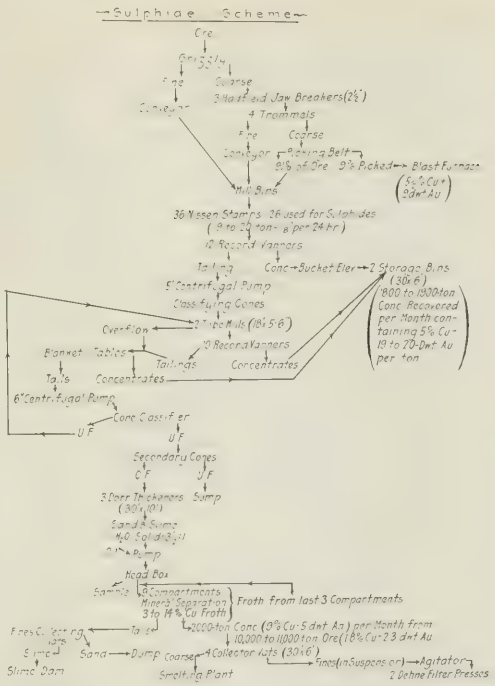


FIG. 4—FLOW SHEET OF MILL OPERATING ON SULPHIDES, FALCON MINE, RHODESIA, SOUTH AFRICA

to 6 dwt. of gold per ton. The chalcopyrite is associated with iron pyrite and pyrrhotite. The oxidized ore runs 0.3 per cent copper and 4 dwt. gold per ton.

Figs. 4, 5 and 6 illustrate the various operations at the mill and at the smelter, and require no further explanation:

It is of further interest to know that the mill concentration plant recovers 60 per cent of the gold and 20 per cent of the copper, while the flotation plant recovers 20 per cent of the gold and 70 per cent of the

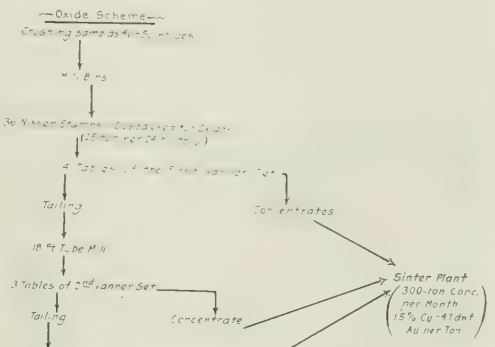


FIG. 5—FLOW SHEET OF MILL OPERATING ON OXIDES, FALCON MINE, RHODESIA, SOUTH AFRICA

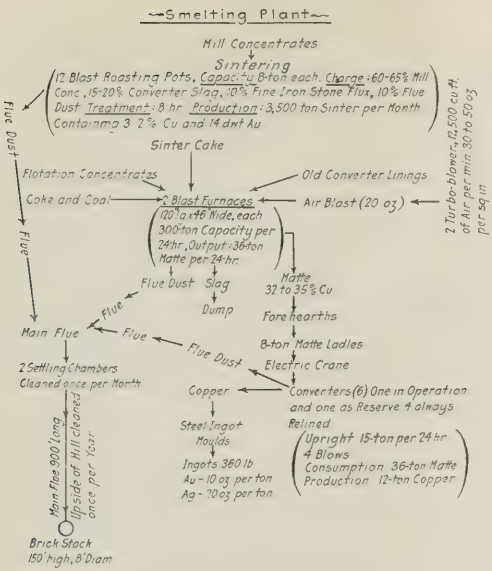

Smelting Plant
Mill Concentrates
Sintering
12 Blast Roasting Pots, Capacity 8-ton each. Charge: 60-65% Mill Conc., 15-20% Converter Slag, 10% Fine Iron Stone Flux, 10% Flue Dust Treatment: 8 hr. Production: 3,500 ton Sinter per Month Containing 3.2% Cu and 14 dwt Au
Sinter Cake
Flotation Concentrates
Old Converter Linings
Coke and Coal
2 Blast Furnaces
Air Blast (20 oz)
2 Turbo-blowers, 12,500 cu. ft. of Air per min. 30 to 50 oz. per sq in
120' Lg. x 46" Wide, each 300-ton Capacity per 24 hr., Output: 36-ton Matte per 24 hr.
Flue Dust
Flue
Slag
Dump
Matte 32 to 35% Cu
Fore hearths
8-ton Matte Ladles
Electric Crane
Main Flue
2 Settling Chambers Cleaned once per Month
Copper
Converters (6) One in Operation and one as Reserve 4 always Relined
Upright 15-ton per 24 hr. 4 Blows Consumption 36-ton Matte Production 12-ton Copper
Steel Ingot Moulds
Ingots 360 lb Au - 10 oz. per ton Ag - 20 oz. per ton
Main Flue 900' long Upside of Hill cleaned once per Year
Brick Stack 150' high, 8' Diam

FIG. 6—FLOW SHEET OF COPPER SMELTER, FALCON MINE, RHODESIA, SOUTH AFRICA

copper. This gives a total extraction of 80 per cent of the gold and 90 per cent of the copper. Also it might be especially noted that little or no flotation concentrates are sintered, but are directly delivered to the blast furnaces.

Recent Metallurgical and Chemical Patents

Caustic Soda

Purification of Caustic Soda.—A process for the electrolytic purification of caustic soda is patented by HERMAN B. KIPPER of Solvay, N. Y. The process is applicable to the different processes for the manufacture of caustic soda, such as the lime-soda and the electrolytic process. In these processes the dilute caustic first produced is evaporated in vacuum pans and later in open evaporating vessels. During the process of causticization and of evaporation in the vacuum pans and in the open or cast-iron pots, small amounts of metals are dissolved, which must subsequently be gotten rid of as far as possible. These have usually been removed by settling, the soda being heated up to 500 deg. C. in the cast-iron pots and allowed to cool gradually. According to the present patent, the caustic liquor from the vacuum pans is electrolyzed with nickel anodes with low voltages and a current density of 50 to 150 milliamperes per square inch. One form of apparatus which can be used is shown in Fig. 1, in which 10 designates the purification vessel for the fused caustic soda, it being shown in the form of an open-topped pot which may be composed of iron, the pot being set in a firebox, 11, whereby heat may be applied to raise the temperature of the caustic liquor to the appropriate point. In order to prevent metal from the sides of the pot from entering the caustic liquor, a diaphragm or lining, 12, of fine wire gauze or semi-permeable structure is arranged within the pot and is supported from the inner

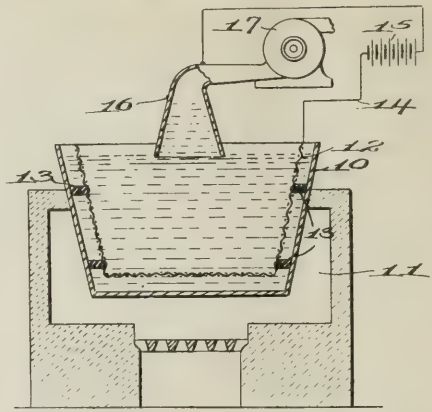


FIG. 1—CAUSTIC SODA PURIFICATION APPARATUS

wall by insulators, 13, the space between the semi-permeable diaphragm or lining and the wall of the pot being filled with powdered limestone. The semi-permeable diaphragm or lining is preferably composed of nickel gauze, and it is insulated from the pot, 10, and is connected by the wire, 14, to one pole of the battery or source of electric current supply, 15. The anode in this construction is in the form of a cone, 16, composed preferably of sheet nickel, the bottom or larger end of the cone being immersed slightly below the level of the caustic liquor in the pot, and the upper end of the conical anode is connected to a vacuum or exhaust pump, 17, which in the operation of the apparatus serves to maintain a slight vacuum within the anode. In this way the caustic liquor is forced up into the anode, the greater portion of the electrical action takes place within the hollow or conical anode, and all oxygen given off in consequence thereof rises through the liquor contained in the cone and is carried off by the vacuum or exhaust pump. (1,227,453, May 22, 1917.)

Waterproofing

Electrolytic Waterproofing.—Three patents have been issued to ALFRED O. TATE of Montreal, Canada, on methods and apparatus for waterproofing fibrous materials. The first patent (1,228,986) relates to a machine for waterproofing, consisting of one or more pairs of stationary electrodes of relatively great contacting surface area, located face to face with their entire surfaces in electrical contact. The positive electrode of each pair is fixed between the ends of a frame, and the negative electrode is adjustable in a parallel plane. The material may be subjected to different electrolytes by spraying on each side as it passes through the electrodes. The second patent (1,228,987) relates to a method of waterproofing consisting in treating fibrous materials with a saponaceous liquid and aluminium acetate simultaneous with the subjection of the material to the action of an electric current between electrodes, one of which is soluble. The third patent (1,228,988) relates to a machine for carrying out the above mentioned process.

The patents are assigned to the Tate Electrolytic Waterproofing Co., Inc., of New York.

Annealing and Heat Treating of Steel and Melting of Non-Ferrous Metals in the Electric Furnace*

By T. F. Baily

The development of electric furnaces for the heating operations subsequent to the melting and refining of steel has been attended by the usual slow process of any radically new development; and the types now in operation are the result of the gradual elimination of weak and faulty features rather than from skill in original design.

In the early development much higher prices were charged for electric current than is now the common rate, and this, in addition to the fact that central stations themselves did not consider electric furnaces commercially feasible, contributed to their slow introduction commercially. The uncertainty of fuel supply and its greatly increased cost within the last year have materially aided the introduction of electric furnaces, and the central stations have of late also taken an active interest in their introduction.

The incidental advantages of the modern electric furnace are so apparent that even at an equal operating cost for fuel electricity now has the preference, while in some cases, where the net cost of operation with electricity is less than with gas or other fuel, complete installations of magnitude are being made.

While it is not the intention to discuss in detail all of the purposes for which furnaces of the type considered in this paper are adapted, the following are some of the uses to which they have been put:

Annealing steel castings and car axles.

Heat treating steel castings.

Heat treating shells.

Carbonizing.

Annealing aluminium, copper, or brass.

Melting copper, brass, aluminium, or silver.

To these lines will shortly be added:

Soaking pits for steel mills.

Rivet furnaces for structural and bridge shops. Later, when there is a serious demand for them, furnaces for heating drop forgings.

It is the purpose of this paper to deal only with furnaces actually in commercial operation.

*A paper read before the Cleveland Engineering Society.

GENERAL DESCRIPTION

All of the furnaces to be described later are of the so-called resistance type, and have, in the case of rectangular furnaces, two troughs made of carborundum fire sand located one on each side of the furnace, with carbon or graphite electrodes located at each end of each trough. The troughs are filled with a broken carbonaceous material called "resistor material," establishing a connection between the electrodes and completing the electric circuit. The general plan of these furnaces is similar to a closed box of fire brick in the walls of which are two glowers, which may be likened to huge incandescent-lamp filaments. The control of the current, and hence the heat, is effected by varying the voltage impressed at the electrodes, this variation being obtained by means of numerous taps on the secondary of a special transformer supplied with each furnace.

CAR-TYPE ANNEALING FURNACES

The furnace shown in Fig. 1 is a car-type 150-kw. annealing furnace, with the capacity of heating 1000 lb. of steel to a temperature of 1650 deg. F. in one hour, and a current consumption of 300 kw. hours per ton of material heated to that temperature. The door of the furnace is a heavy casting faced with fire brick and backed by a filling of loose kieselguhr held in place by a steel plate.

The car-type furnace shown in Fig. 2 is the same in type, but of 300 kw. capacity, and is located in the same plant as the previously described furnace, and is used for annealing steel castings. The charging door is raised, showing how the fire brick car-platform forms the floor of the furnace. Furnaces of this type are well adapted for handling steel castings, and equally well for heating large or irregularly shaped forgings, or for the annealing of copper and aluminium, to which latter use they have already been put.

CONTINUOUS PUSHER-TYPE FURNACES

When materials are of uniform size, or of such shape and nature that they can be pushed along mechanically, or placed in containers of uniform size, the continuous furnace (shown in Fig. 3) is sometimes preferable to the car-type annealing furnace (shown in Figs. 1 and 2).

Fig. 3 shows a 120-kw. furnace carbonizing rifle receivers in one of the large rifle-making plants in the East. The parts to be carbonized are placed in the

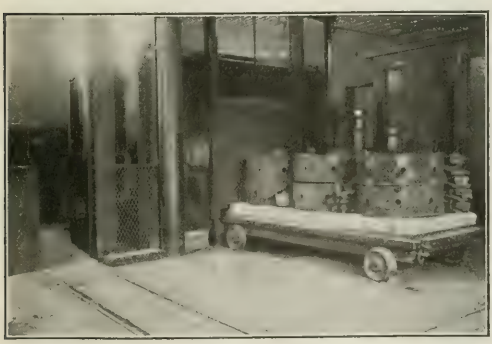


FIG. 1—150 KW. CAR-TYPE ANNEALING FURNACE

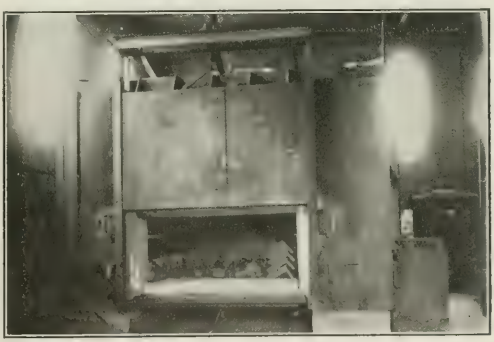


FIG. 2—300 KW. CAR-TYPE ANNEALING FURNACE

usual pots and are pushed through the furnace by means of the pushers, as shown.

Other furnaces of the same general type, but with a different type of pusher, are used for annealing brass and German silver flatware blanks in one of the oldest and best known plants making plated tableware. Two of these 200-kw. units in operation at this plant have an hourly capacity of 1 ton of brass each.

AUTOMATIC HEAT TREATING FURNACES

The heat treatment of steel, as distinguished from the simple annealing operation, consists of heating the metal to above a critical point, quenching at that temperature in some cooling medium, such as water or oil, and subsequently reheating to a temperature under the critical point mentioned.

As materials with specified heat treatment are usually placed in locations where they are to be subjected to considerable strain, more attention has been given to so-called heat-treating operation than to the usual annealing, although both annealing and heat treating are equally important, if dependence is to be placed on the effect that is expected.

For the highest quality of work in heat treating, two furnaces are recommended, each one running with the ruling temperature desired in the material at that particular stage of its treatment, and a quenching bath (or spray, as the case may be) located between the discharge end of the first or heating furnace and the charging end of the second or drawing furnace.

The material is gradually moved forward by a pusher (such as is shown in Fig. 3), removed by manipulators, and quenched in a tank. It is later removed and placed in front of the drawing furnace (as shown in Fig. 3), and later, after having passed through the drawing furnace, discharged and cooled in a specified manner. These particular furnaces, of which there are two sets of two furnaces each already installed in one of our progressive manufacturing plants, are used in the heat treatment of cast-steel drawbar knuckles. Each set has a capacity of 72 tons of steel per day and consumes 900 kw. per set.

These particular furnaces, and a similar set of 600-kw. furnaces for heat treating large high-explosive shells, are automatically controlled by special pyrometers, so that the only hand work required is the placing of material on the charging platform of the first furnace of the set.

Equipment of this type, while expensive in first cost, approaches very closely the highest point of commercial efficiency, as they not only leave no operation to chance but reduce the labor items to a minimum. I believe that it may be said of one of these units that hundreds of thousands of pieces have passed through it without a greater variation in temperature than 10 deg. from the stipulated point.

This type of equipment is adaptable where the material to be heated is of uniform section, or can be placed in suitable metal containers, and where extreme accuracy and minimum labor cost are desired. With such an installation it is possible to produce a uniformity in the product in the plant in line with the tests of the laboratory.

MELTING FURNACES FOR BRASS

The reliability of the type of furnaces described above for annealing and heat-treating work seemed to justify the assumption that with the necessary modifications as to hearth and shape of furnaces they would work equally well on non-ferrous metals. The first furnace for this purpose was installed three years ago for melting silver in one of the plants mentioned previously, where continuous annealing furnaces are used for annealing brass flatware blanks. This furnace was rectangular in shape and provided with a hole in the top and the necessary cover. The metal is melted in crucibles, the furnace being adapted to hold two crucibles of size No. 40. Not only is silver melted, but

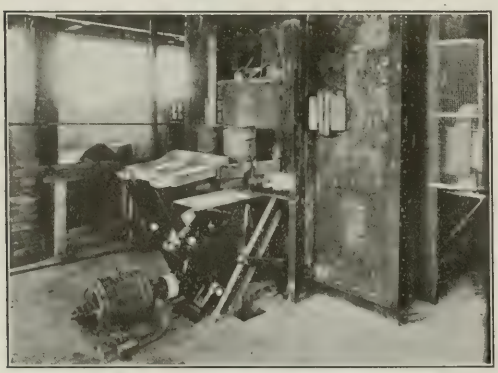


FIG. 3—120KW. CONTINUOUS PUSHER TYPE HEAT TREATING OR CARBONIZING FURNACE

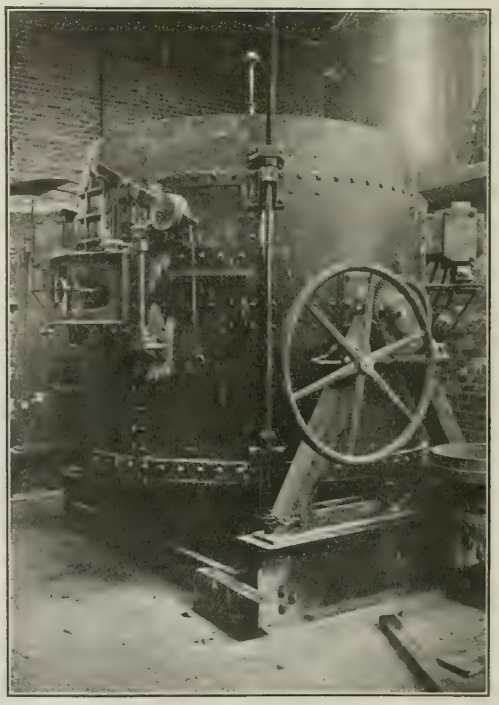


FIG. 4—105 KW. TILTING-HEARTH MELTING FURNACE

scrap copper as well. The ruling temperature of the furnace is 2500 deg. F., very hot metal being required, as the castings are small and the molds are heavy iron chills.

There seems to be no real necessity for the use of a crucible excepting in the melting of precious metals. Their high cost, rapid destruction, and the necessity of handling small quantities of metal when they are used, with attending high labor charge, has led to the adoption of the tilting-hearth furnace shown in Fig. 4. This type of furnace was first used for aluminium and aluminium alloys, and later the same type, with slight modifications in the details, has been used to melt brass.

This furnace, with a normal rating of 105 kw., and a melting capacity of 600 lb. per hour, has melted, and superheated to a suitable pouring temperature, the following materials, with an average current consumption as noted below:

New Red Brass—400-lb. heats in 1 hr. with 90 kwh. or 450 kwh. per ton.
Scrap Yellow Brass—(72 per cent Cu. 28 per cent zinc) 750-lb. heats in 1 hr. 10 min. with 120 kwh. or 320 kwh. per ton.
Scrap Yellow Brass—(70 per cent Cu. 30 per cent zinc) 800-lb. heats in 1 hr. 18 min. with 110 kwh. or 275 kwh. per ton.
Brass Chips and Borings—(70 per cent Cu. 30 per cent zinc) 700-lb. heats in 2 hr. 30 min. with 220 kwh. or 720 kwh. per ton.

Much lower current consumptions have been made on individual heats, but the above are the averages of several heats of each metal.

Of all the electric furnaces of the type described now developed, the tilting-type furnace is the one offering the greatest saving in cost over fuel-fired furnaces of any type, whether oil, gas, or coke fired, since the metal loss is lower, the crucible cost is eliminated entirely, while the labor item is less on account of size and convenience of operation.

The following figures may be safely taken as operating conditions with yellow brass in a shop operating 24 hours per day:

Electricity, 400 kw.-hr. per ton at 1 c	$4.00 per ton
Metal loss, 1 per cent zinc at 10c. per lb.	2.00 per ton
Labor, 1 man per hour per 600 lb., at 40c. per hour	1.20 per ton
Renewals and repairs	1.00 per ton
Total per ton of melt	$8.20

It is believed that the performance of these brass-melting furnaces is such, and the saving over other methods so great, that their introduction will be rapid, even much more so than the annealing and heat-treating furnaces described, which are now accepted without question.

Electric furnaces are not a cure-all for the troubles in the metal industry. They are, however, a much more accurate and precise tool than fuel-fired furnaces, and are the means of eliminating many of the troubles in metal production and manipulation, and will, in the lines for which they are adapted soon come into as general use for heating as electric motors have for power.

The Electric Furnace Co. of America,
Alliance, Ohio.

Porcelain Pyrometer Tubes

For the purpose of protecting thermo-couples at furnace temperatures the tubes made of Marquardt refractory porcelain by the Royal Berlin Porcelain Manufactory have proven very successful, as is shown by the experience of many years. These protection tubes, owing to war conditions, are now not obtainable.

The need of effective protection for the costly platinum and its alloys so extensively used in pyrometry prompted investigation and manufacture in this country. The Ceramic Section of the National Bureau of Standards carried on experiments for the purpose of reproducing, and if possible of improving upon the Marquardt porcelain. The result was a highly refractory product which, though made entirely from American raw materials, was found to be of most excellent quality. The manufacture of this porcelain was taken up by the Stupakoff Laboratories of Pittsburgh, Pa., who successfully overcame the unavoidably attending difficulties, and brought on the market a protection tube under the name "Usalite."

It is claimed by the manufacturers that tubes of this material will readily withstand exposure to temperatures exceeding 1650 deg. C. A highly refractory glaze covers the surface of the outer pyrometer tubes in order to make them impervious to gases of combustion. In strength tests, 5/16 inch unglazed inner tubes; on supports placed 5 inches apart, broke under a centrally applied load of 20 pounds. Outer tubes of standard size 11/16 inch diameter, submitted to the same test broke at 212 pounds.

An 18-in. outer tube, freely suspended at its upper end, broke under impact test by applying a 50 pound weight to its lower end when swinging from an angle of 90 deg. Exposed to a temperature of 1370 deg. C., standard outer Usalite tubes in a horizontal position and unsupported for 6 inches did not bend during six weeks' continuous service.

Usalite tubes, when withdrawn from white hot furnaces and brought into the open air neither broke nor cracked. The smaller diameter unglazed tubes effectively withstood sudden exposure to the highest temperature. A glazed outer tube heated to 1100 deg. C. readily withstood the introduction of cold steel rod of nearly the same diameter as that of the bore of the tube.

Rare metal thermo-couples and resistance thermometers, which are made of platinum and platinum alloys, require considerable protection. These metals, when heated, absorb large quantities of gases and metallic vapors, and when in this state they also readily combine with phosphates and silicates, all of which contribute to causing physical changes and making them unfit for their intended use. For these reasons the insulating tubes, containing the active portions of the pyrometers, are slipped into other (outer) protection tubes with closed ends. These tubes, besides possessing all the properties required of the inner tubes, must remain impermeable to gases at high temperatures.

Impermeability is imparted to porcelains by glazing their surface. The best of such glazes begin to soften at about 1400 deg. C. (about 2550 deg. Fahr), whereafter imperviousness rapidly diminishes. Pure silica and the silica glazes of porcelain tubes at high temperatures devitrify in a reducing atmosphere and combine with alkaline substances. It is therefore recommended to enclose, whenever possible, the outer pyrometer tubes in others which combine mechanical strength with refractoriness and density of structure. These shields, which are commonly known as pyrometer tips, serve as an effective protection for the fragile pyrometer tubes against breakage through mechanical injury and sudden changes of temperatures, beside, serving as effective filters of furnace gases and vapors.

Fundamental Hue Scale for Scientific Color Designation

Dye manufacturers and those who deal in or have much to do with various kinds of dyes will without doubt gladly welcome anything that will tend to increase the accuracy of color designation and nomenclature. They will, therefore, be interested in an extensive series of experiments recently carried on in the Research Laboratory of the Eastman Kodak Company for the purpose of obtaining a fundamental color scale.

There are two ways of analyzing and specifying color, one being the trichromatic method of analysis in terms of the three primary component colors, red, green and blue, and the other the monochromatic method of analysis in terms of the wavelength of the dominant hue or its complementary hue and the per cent white (purity or saturation). The fundamental color scale as determined in the Kodak Research Laboratory is based on the monochromatic method of analysis, and it is the purpose of this article to show how important this method is to any one interested in reliable color nomenclature and describe the method of determining the unit for the color scale.

When light rays from the sun or other luminous object or substance impinge upon the retina of a normal eye, sensations of light are produced, and in such sensations two factors may be distinguished, one being a factor of brightness and the other of color. The sensation of brightness is dependent upon the intensity of the light and that of color upon what may be termed the "quality" of light radiation. Light energy is transmitted in the form of waves of varying wavelength, and the quality of the light radiation, which the eye perceives as color, is dependent upon the length of the waves.

Pure color is produced by homogeneous light—that is, light of equal wavelengths. Usually, however, colored light is made up of a number of different kinds of wavelengths, and the eye cannot recognize the individual component wavelengths, but averages the mixed radiation as a single stimulus which produces a single color sensation. When a color is produced by light of one wavelength which exactly matches the single-color sensation of mixed radiation, the color is called the dominant hue of the mixture. Moreover, the extent to which the light consists of wavelengths of different color varying about that of the dominant hue as an average is called the "saturation" or "purity" of the color, a pure hue being produced by waves of only one length, while less saturated colors consist of waves of varying length. Light such as that coming from the sun, for instance, consists of a variety of wavelengths, the combination of which causes a sensation of white light to be produced. Sunlight can be broken up into its various components by means of a glass prism or diffraction grating, thus providing the various colors of the spectrum.

The sun, of course, is our greatest source of light, and spectral colors obtained from noonday sunlight are accordingly by far the best colors to take as standards in the preparation of a fundamental color scale. The number of gradations of color, or hues as it is more proper to call them, perceptible to the eye in the spectrum depends upon the experience of the observer and the apparatus used, varying from the six so-called dominant hues (red, orange, yellow, green, blue and violet) to 128 distinct hues distinguished by careful observation with the special apparatus used for this purpose.

It can be demonstrated experimentally that with the exception of the purples, any color can be matched by adding white light in the proper proportions to spectral light of some definite hue (monochromatic or pure single-color light), and the saturation or purity of the color is indicated by the extent to which the color departs from the condition of monochromatism. In this way a direct measurement of fundamental properties of a color can be made, the hue being specified by the wavelengths of the monochromatic light used (wavelengths of the dominant hue) and the purity or saturation by the ratio of the intensity of the white light to that of the monochromatic light (per cent white).

In the case of the purples for which there are no spectral colors to represent their hues, some mixture of the color with monochromatic light can be made by which the sensation of white will be produced, the terms of the color specification then being the wavelength of the complementary dominant hue (the hue which when mixed in the proper proportions with the color to be matched produces white) and the per cent of monochromatic light in the mixture (per cent hue).

Now it seems to be apparent that, since wavelengths of radiation is used to express hue, if a hue scale is to be established, the points on the scale should be designated in wavelength units. It has been found, however, that equal wavelength differences do not produce equal color sensation differences throughout the sensation scale under consideration. Hence, the wavelength unit is not suitable for use as a unit in the establishment of a scale of subjective color sensation, since the first requirement of a scale for the measurement of any quantity is that the unit used shall be of a fixed magnitude and of the same value throughout the scale.

The only alternative is to adopt the least perceptible color sensation difference as a unit and assume that this sensation unit is equal at all points in the sensation scale. This unit is called a limen and is the least perceptible difference between two hues in terms of μ (wavelength is usually given in terms of ten-thousandths of a centimeter, the unit being expressed by the Greek letter μ). The question as to whether such a sensation difference unit is equal at all points on any sensation scale has been discussed at great length by philosophers and psychologists; but from a purely physical standpoint, it seems entirely reasonable to make the difference limen equal at all points on a sensation scale by definition and to adopt this least perceptible difference as a sensation unit and to use it for the establishment of color sensation scales.

The problem of establishing a fundamental hue scale then, after finally getting down to the meat of the matter, is to determine for the entire range of visible radiation, going from red to violet, or vice versa, the relation existing between the wavelength unit and the least color sensation difference unit. In the solution of the problem the first step is the determination of precise values in terms of the wavelength units for the average normal eye of the least perceptible hue differences (sensation units) throughout the visible spectrum. The final values, then, must be the result of the

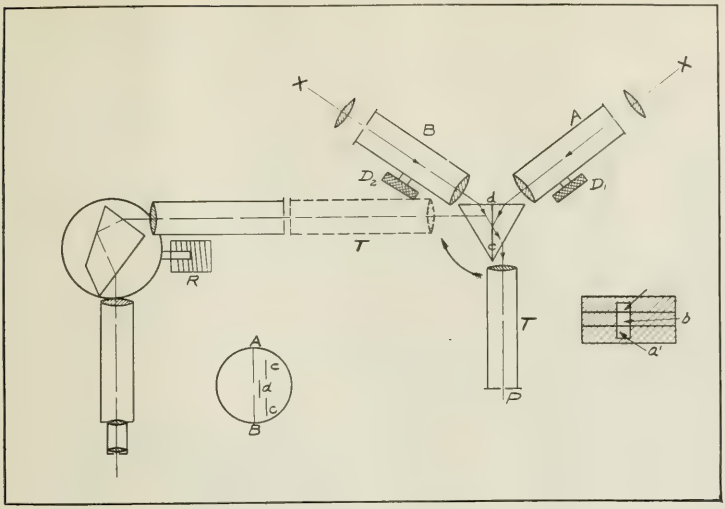


FIG. 1—ARRANGEMENT OF MEASURING APPARATUS

proper summarization of a large amount of data obtained from the study of a large number of different individuals having normal vision.

In the measurement of the difference limen highly refined apparatus is required. Considerable data were obtained in the Kodak Research Laboratory with a Brace Spectrophotometer, which was used in connection with a Hilger spectroscope of the constant deviation type. The arrangement of this apparatus is indicated in the diagram in Fig. 1. A and B represent two collimating systems, the angular positions of which can be adjusted by means of the micrometer screws D_1 and D_2. The prism consists of two 30-deg. elements cemented together along the line ed, thus forming a compound 60-deg. prism. On one of the cemented faces is a narrow silvered strip (about 8 mm. wide) which is parallel to the base of the prism and centrally placed in the vertical direction. By looking through the pinhole ocular P of the telescope T over the object glass of which is placed a diaphragm with a rectangular opening, a field as shown at the right in Fig. 1 is seen. The portions of the field aa′ appear to be illuminated by monochromatic light from the system B and the area b by light from the system A.

The entire system is mounted on a table in such a manner as to bring the telescope T into alignment with the collimating system of the Hilger spectroscope. By looking through the eyepiece of the Hilger instrument and by bringing the lines in the field on to the cross line of the eyepiece, the wavelength of the light entering the slit, from the fields aa′ and b of the spectrophotometer can be accurately measured. The field that can be seen is shown in Fig. 1. A B is the reference line of the eyepiece, cc′ the lines due to the light coming from the portions aa′ of the spectrophotometric field and d is the line due to that from the portion b. The wavelength of each can be precisely measured by bringing them one after the other into coincidence with the reference line A B, reading the value directly from the calibrated wavelength drum R.

With the apparatus shown the difference in the wavelength of the light illuminating two fields, which appeared just perceptibly different in hue, was obtained. Since the desired scale is that of pure hue, fields illuminated by light as nearly monochromatic as possible must be used in such work, and it is also very important that the intensity of the light be easily controllable, for in making a judgment of equality or difference hue, it is necessary to maintain an intensity balance between the fields in order that the judgment of hue may not be influenced or confused by the existence of an intensity difference.

In Fig. 2 are shown two curves plotted from data obtained in the Kodak Research Laboratory. The abscissa or horizontal values are given in one-thousandths of μ (designated as $\mu\ \mu$), the violet hues being in the

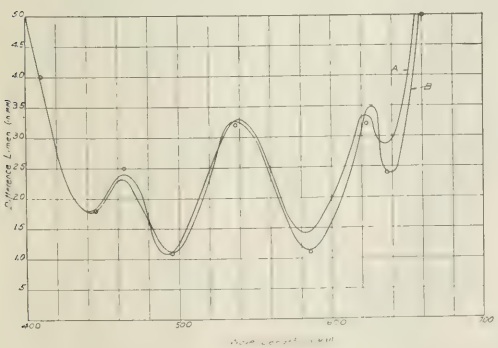


FIG. 2—TWO TEST CURVES

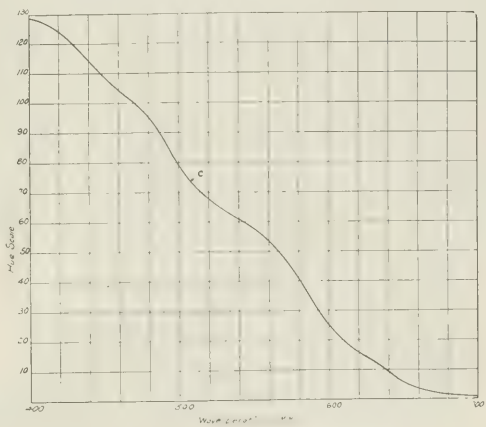


FIG. 3—HUE-SCALE READING CURVE

neighborhood of 400 μ μ; blue, 480 μ μ; green, 520 μ μ; yellow, 589 μ μ; orange, 600 μ μ; red, 660 μ μ. The ordinate values are difference limen or smallest perceptible hue differences in terms of μ μ in various parts of the spectrum. These curves agree very well with curves plotted by other observers and they prove the statement already made, that equal wavelength differences do not produce equal color sensation differences.

In Fig. 3 is shown a hue-scale reading curve, the data being obtained by a method that involved the use of the least perceptible hue difference as the *actual unit* of measurement. Starting at a given point the entire spectrum was measured off step by step with the difference limen as the unit of length. This method gives the total number of just perceptibly different hues present in the spectrum and the distance apart of these equal sensation steps in terms of the wavelength unit. The number of distinct hues found in the Kodak Research Laboratory in a very careful set of readings was 128 between 400 μ μ (violet) and 700 μ μ (red). By plotting the consecutive wavelength readings as abscissae against equal ordinate increments—these readings correspond to equal sensation steps—the scale-reading curve as shown was obtained directly.

How great the value of a fundamental hue-scale with the least perceptible hue differences as a unit may be can now be readily ascertained from a close study of the scale-reading curve shown in Fig. 3. Let one imagine, for instance, that the hue-scale shown has been definitely adopted and standardized, then it is easy enough to state the position of the dominant hue on the scale and to complete the specification by giving the degree of purity or saturation of the color.

A New Carbon Electrode Factory

Work has already been started on the first unit of a new factory that will form an immense addition to the present large plant of the Speer Carbon Company at St. Marys, Pennsylvania, and which, when entirely completed, will involve the expenditure of approximately $500,000.00 for additional land, buildings, machinery, equipment and general improvements.

The new factory will occupy the plot of ground east of the present plant, and it is expected that a number of similar units will be erected as labor and materials are available. The company has been acquiring additional land immediately adjoining its present large holdings.

The first building, which will be devoted exclusively to the manufacture of the larger sized carbon electrodes for electric furnaces, will be 100 x 168 ft. in size and constructed entirely of brick, concrete and steel. Glass sidewalls will also be employed, thus permitting a volume of daylight throughout the entire structure. The contract for the erection of the building has been awarded to the W. L. Goeltz Company of New York City. The erection of the furnaces and the installation of the machines and equipment will consume several weeks, but it is expected that the entire plant will be in full operation by September, 1917.

The Speer Carbon Company has for several years past manufactured carbon electrodes in the smaller dimensions, the maximum sizes including 4 in. square and 6 in. in diameter. The new factory will be equipped to turn out both round and square electrodes in all sizes from 6 to 24 in. in diameter.

The demand for carbon electrodes is daily increasing, the condition being caused by the enormous demand for tungsten steel and other products which, in turn, necessitated the installation of large numbers of electric furnaces throughout the entire country. The requirements of the Government have also influenced the Speer Carbon Company very largely in the erection of a new plant and once it is in full operation the carbon electrode shortage will be greatly lessened.

Tripod Stand for Portable Galvanometers

The tripod stand shown in the accompanying photograph, Fig. 1, is a product of the Stupakoff Laboratories, of Pittsburgh, Pa. It was designed to do away

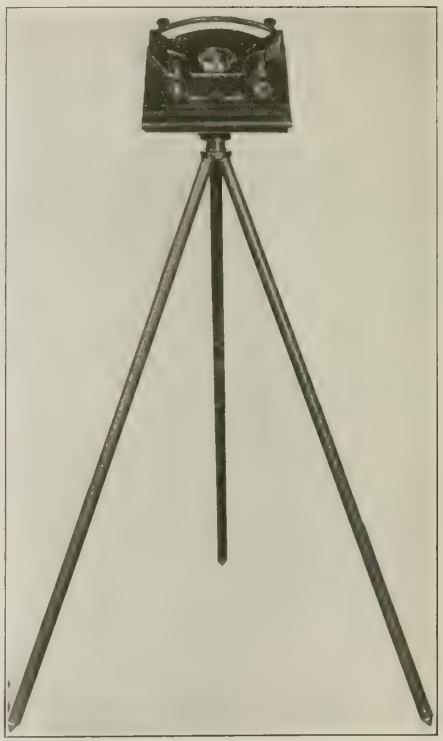


FIG. 1—TRIPOD FOR PORTABLE GALVANOMETERS

with the inconvenience of finding a suitable resting place for portable galvanometers. The stand is designed to fit all of the company's instruments.

Manganese Mining Active.—Secretary Lane recently made the following statement on manganese: "The manganese situation is most encouraging and the U. S. Geological Survey estimate for 1916 is 80,000 tons of the high grade ore. This, however, is less than 20 per cent of the present large demand of the steel industry. Production of low-grade ore is also increasing.

Personal

Mr. **L. W. Bahney** has left the Sheffield Scientific School of Yale University to take a position as metallurgical engineer with the Scovill Manufacturing Co., Waterbury, Conn.

Prof. **H. K. Benson,** instructor in industrial chemistry at the University of Washington, Seattle, and director of the Bureau of Industrial Research, will spend his summer vacation at the plant of the American Nitrogen Products Compnay at La Grande, Wash., where he will conduct research work relating to the manufacture of nitrogen products from the air by use of electricity. Prof. Benson will return to his school work in the fall. He is an associate member of the U. S. Naval Advisory Board.

Mr. **Arthur F. Braid** has assumed the duties of metallurgical engineer in charge of metal sales for the Goldschmidt Thermit Co. of Jersey City, N. J. He succeeds DeC. Brown, who has joined the Officers' Reserve Corps at Plattsburg.

Prof. **G. H. Clevenger** of Leland Stanford, Jr., University was recently in New York, having just returned from the Cobalt District in Ontario, where he has been making some investigations for the Bureau of Mines.

Mr. **S. C. Dickinson,** formerly with the United States Bureau of Mines, assumed the duties of safety engineer with Arizona State Bureau of Mines on July 1.

Mr. **B. H. Dosenbach,** flotation engineer for the Butte, Superior, was in Denver on business.

Mr. **S. L. Nicholson,** sales manager of the Westinghouse Electric & Mfg. Co. since 1909, has been made assistant to the vice-president of the company, with headquarters at East Pittsburgh. Mr. **H. D. Shute,** whose election as vice-president of the W. E. & M. Co., was recently announced, will have executive charge of the company's commercial organization, both domestic and export, succeeding vice-president L. A. Osborne, whose headquarters have been transferred to New York.

Mr. **Burr A. Robinson** has resigned as assistant secretary of the American Institute of Mining Engineers to go into industrial work, and Prof. **G. A. Roush** of Lehigh University has taken up his work as managing editor of the Institute's Monthly Bulletin.

At the commencement of the Colorado School of Mines the honorary degree of E.M. was given to **Walter G. Swart** and **H. W. Hardinge.**

Mr. **O. H. Wharton** is the new president of the Crucible Steel Co. of America. He is a native of Easton, Pa., and was for many years general sales manager of the company, following which he was assistant to president C. C. Ramsey.

Mr. **Kwong Wu,** mining engineer for the Ministry of War of China, spent several weeks at Nederland, Col., inspecting the various tungsten mills of the district.

CURRENT MARKET REPORTS

The Iron and Steel Market

There is little to be said about the iron and steel market. It appears to be in the throes of a transition from its recent runaway condition to a state of being regulated by Government authority. The regulation of iron and steel prices, which an amendment to the food bill in the Senate places in the power of the President, is likely to remain in the bill for its final passage, and the President is likely to exercise the authority when granted, unless the manufacturers are able to devise a system under which the trade can operate to the satisfaction of all parties concerned. This may be undertaken, though the experience of the coal operators does not encourage them to undertake to do anything that will satisfy more than one or two Cabinet officers at a time. It will be recalled that the agreement of the coal operators was made with the Secretary of the Interior, who was well pleased, and as soon as the secretaries of the War and Navy departments read about it in the newspapers they hastened to "repudiate" it, though they afterwards reconsidered their dictum.

The steel market has grown narrower and narrower, as to the tonnage turnover. The mills have withdrawn more and more from the market, while buyers have become more and more averse to making engagemenets for far forward deliveries. The business done has been confined more and more to early deliveries, with a very few months. For such deliveries there are very few buyers and very few sellers, hence an extremely narrow market. The buying pressure has preponderated, however, and the market prices disclosed by the few transactions made have shown an almost constant advancing tendency. As the prices are, on an average, about double the prices at which the bulk of the shipments are now being made, on old contracts, they are in large manner fictitious, though strictly speaking they represent the market since there is no other market to quote.

PIG IRON

The pig iron market is much broader than the steel market, in that there are transactions involving the delivery period for which the majority of the furnaces are in position to sell. Sales for the first half of 1918 involve a much larger tonnage than sales for the remainder of this year, and occasionally there has even been a little business done for the latter half of 1918. Prices show but little divergence for the different deliveries, though in most cases there is a difference of from $1 to $3 a ton. All districts except Alabama and Tennessee now show a market price of $50 or higher f.o.b. furnace, approximately three times the price at which a great deal of iron was sold for delivery during the first half of the current year.

The pig iron market, however, has grown decidedly quieter in the past fortnight. The volume of transactions has greatly decreased, and price advances seem almost to have ceased. Indeed, there are some indications that southern iron is scarcely as firm as a fortnight ago.

GOVERNMENT STEEL

The war requirements in steel are multiplying, but there is little concrete information as to tonnages, and nothing like a close estimate can be made as to the prospective total. It may be remarked however, that at the time war was declared estimates of war requirements ranged from 5 to 20 per cent of the output, while a month ago the more enterprising were disposed to predict 40 per cent, and at present there are many who

believe the total requirements will exceed 50 per cent. The change in view is due to the fact that the Government finds it necessary to engage in more undertakings than was expected. If steel can be secured and fabricated there are prospects that large numbers of cars and locomotives will be bought, both for domestic use and for export, and it may be found desirable to foster the manufacture of agricultural implements and engage in other enterprises. These extra items would represent peace steel taken in change by the Government for war purposes.

Non-Ferrous Metal Market

Monday, July 9.—The markets are in a slightly easier position, with the exception of tin, which is practically unchanged. Copper has declined slightly, lead is lower in the outside market and antimony has declined considerably. The situation in spelter is unchanged. Silver remains high and firm.

Copper.—The Government purchased on June 29, 60,000,000 lb. of copper at 25 cents. The price, however, is understood to be tentative and subject to investigation by the Federal Trade Commission of the cost of production. The average monthly exports so far this year have been over 100,000,000 lb., or more than twice last year's amount. Since the first of July the copper market has been quiet pending Government action on copper prices. Electrolytic has declined from 32.25 on June 27 to 31.25 on July 6. Lake has remained practically stationary at 31 cents.

Tin.—Tin has been firm with a slightly upward tendency. Spot Straits is held at 62.00 to 62.50 cents. August delivery, 61.00, September 59.50-60, October 58.50 and November 57.50. June deliveries are estimated by the American Metal Market to be about 5000 tons. There has been a noticeable increase in the supply of tin other than Straits.

Lead.—The feature of the lead market has been the lower outside market. Lead sold up to 12.00 cents in this market a short time ago, but is now down to 11.25. The Trust price remains stationary at 11.00 cents.

Spelter.—The Government purchased 11,000 tons of high grade spelter the last week in June, for delivery over the next 10 months. The price was 13.50. This purchase did not have any noticeable effect on the market, and consumers are still holding off. The demand for spelter is very poor and the market continues dull. Prompt spelter is quoted at 9 to 9.25 cents.

Other Metals.—Antimony has declined from 18.75 on June 27 to 16.75 on July 6. Consumers are apparently well supplied and the good supply made an easy market. Antimony is stronger in China, owing to the disturbed conditions, but developments there have not affected the market here as yet. Aluminium is lower at 56 to 58 cents for No. 1 Virgin metal. Magnesium is $2.00 to $2.50 for prompt shipment. Quicksilver is $85.00 per flask. Platinum is unchanged at $105.00 per oz. Silver is 78⅜. The situation in tungsten concentrates is very acute and concentrates are hard to obtain. They are quoted at $20-$22 per unit.

Chemical Market

Generally speaking, there has been little excitement in any division during the interval and prices have in the large majority of cases moved within rather narrow margins. Buying has been more or less on a rather limited scale due in part to the growing difficulty of exporting merchandise when there is a foreign market and also to the fact that in the absence of further definite advices from the government regarding those materials that are essential in the furtherance of defensive and offensive measures, buyers, and in not a few instances sellers, are withdrawing from the market as far as possible for the time being. On the other hand, many chemicals, such as caustic soda, aqua ammonia, sulphate of ammonia, etc., which are in relatively light supply, have been subject to a particularly heavy demand and prices have accordingly registered material advances.

Benzol.—On the whole there has been little activity and in many instances manufacturers have accumulated moderately large quantities, which have been held with more or less steadiness pending the government's requirements regarding purchases of picric acid. The question is now whether or not the government's requirements for T. N. T. will be taken care of. In the event that the T. N. T. cannot be supplied in sufficient quantities, it is almost certain that orders for picric will be forthcoming. Large producers have established a minimum of 55c. for nearby deliveries, and while this price is generally adhered to some concessions are being made by those who are less confident of the future.

Among the benzol derivatives *Aniline Oil* has continued to play a fairly important role, and the market has held with some steadiness, due more to the relatively high cost of production than to any unusual demand; the market for *salts* has been fairly well maintained and those concessions that were made were due mostly to inferior grades. *Paranitraniline* has been quiet and production appears to be somewhat heavier than immediate needs. On contract, prices are shaded materially, although the spot market is not subject to great weakening. *Dimethylaniline* has kept up only because of the increasing cost of production, as export business and domestic orders have been light. *Monocolor benzol* is being produced on a wider scale and important makers have reduced both spot and contract prices.

Toluol.—Among all the coal tars this has played the most conspicuous part, due to its importance in the manufacture of explosives as well as in the production of much wanted derivatives. At least four large makers are now under contract for their entire production of T. N. T. for the government and the price paid is based on toluol at $1.50. For those who have not their own by-product recovery plants the government has been buying toluol, but the attitude of the officials at Washington has changed, and it is stated that T. N. T. makers will hereafter have to supply their own toluol. Small lots of *toluol* are being sold steadily for dye making and as a rule at moderately lower prices than those that prevailed two weeks ago. *Paratoluidine* and *paranitro toluol* have been subject to pressing demand and the output up to this time is hardly taking care of the needs of consumers. *Toluidine* also has been in good request, and with limited supplies the market has been maintained with considerable strength.

Phenol.—Apart from the running contract business, routine demand from dyestuffs and intermediate makers, occasional orders from abroad, especially Japan, there has been little activity and prices are not held with any particular strength. Production continues large and is capable of meeting the needs from all directions. *Dinitro phenol* is being made on a larger scale and compe-

tition has induced in some cases a lowering of prices. Contracts are to be had now at fairly large concessions from recent levels. *Para amido phenol* and *paraphenylediamine* are sought after with comparative steadiness, and some makers have advanced their prices. There is no open market for *picric acid* and until the government expresses a desire for supplies the market will be nominal, with little demand and a small production.

Naphthaline.—The absence of wide inquiry has brought prices down fractionally and there is no really important business in progress either for the flakes or balls. Practically all the derivatives of this base are in light demand and prices have declined, some slightly and others materially. The competition for *alpha-naphthylamin* business has induced lower prices, although the output is as a rule being taken up steadily.

H-acid (Amido naphthol di sulphonic acid).—Again this intermediate is brought into prominence by the knowledge that one other maker who has been working on the product for a long time has finally been able to offer material quantities for immediate delivery and regular supply.

Bleaching Powder has been on the down grade for some time, and both domestic and export containers of all kinds are now available at lower prices than have been in existence for a long time. The facts that paper mills are not busy, that some are using their own liquid bleach, that in summer bleach loses its chlorine strength rapidly, and that export business is negligible, have all been factors in bringing about the weak condition.

Potash Compounds.—Muriate has been subject to but light demand, and prices for the syndicate's goods have been reduced materially. A factor has been the importation of more desirable Japanese goods as well as the offerings of domestic kelp potash. *Bichromate of potash* has been inactive, although prices have not fluctuated except within narrow margins. *Caustic potash.* All grades not being under noteworthy buying pressure have eased off somewhat, as manufacturers' supplies have increased. *Carbonate of potash,* both hydrated and calcined, is in light supply, and the most recent business that passed has been at comparatively high levels. *Potash alum.*—Lump prices have been subject to upward revision, due to the demand and higher cost of production.

Soda Compounds.—*Caustic soda* has taken by far the most important position as far as active trading is concerned. The market is in a tight position and while there are spot goods here in New York they are held in strong speculative hands and the market is being forced up to high levels. The interest now centers in 1918 contracts to an extent equal to the spot demand and in fact all positions from July delivery to the end of 1918 are subject to weighty demand.

Soda Ash.—This market has not followed, as usual, the fluctuations of the caustic market, and prices have remained at comparatively low levels. The absence of heavy demand, of course, is responsible. The fact that steamship companies will not accept ash packed in bags, and are now even stipulating that it must be packed in nardwood casks, has an important bearing on the position, as, on account of the tight cooperage situation, a very large proportion of the output is packed in bags.

Bichromate of soda has been moving with moderate briskness, and some makers are still trying to bull the market now that one maker is out and the productions of two more have been sold up for the next several months. *Silicate of soda* is subject to wide demand and manufacturers are still unable to deliver for some time to come. *Nitrate of soda* has advanced considerably under heavy buying, both for domestic needs and export. *Nitrite of soda* is now being made here in somewhat larger quantities, but as yet only the two large producers are delivering, and their product is sold ahead for some months. The demand is wide and prices are high.

Ammonia Compounds.—*Sulphate* production in this country is not taking care of fertilizer needs here, and some of the numerous export orders are going unfilled. *Aqua ammonia* and *nitrate of ammonia* are in such demand that prices, especially of the former, have increased perceptibly every few days and any supplies offered at moderate prices are immediately picked up.

Acids.—*Acetic,* especially 80 per cent. redistilled and pure and the glacial, have been offered here during the interval in quantities that have not been available for many months; the result was that the high prices sagged considerably, but the market is strengthening again to near the former levels, as the goods are being sold to go into consumption. *Muriatic acid* is offered at fractionally lower prices and while there is a tendency to maintain certain levels desirable business is given consideration. *Nitric acid,* on account of the higher cost of the nitrate of soda, has been advanced and makers are now endeavoring to get 12c. per unit for all grades; the demand, however, at these levels is not forthcoming and the market is quiet. *Sulphuric acid* (*brimstone*) has been shaded in a few instances when good orders come into the market, despite the fact that the higher cost and uncertainty of securing brimstone has produced a fundamentally stronger tone. This is more in evidence on future positions and most makes will not take business further ahead than August.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 6, 1917

Acetic anhydride	lb.	1 70	—	1.90
Acetone, drums	lb.	.29		.29½
Acid, acetic, 28 per cent	lb.	.05		.05½
Acetic, 56 per cent	lb.	.10		.11
Acetic, glacial, 99½ per cent., carboys	lb.	.34	—	.35
Boric, crystals	lb.	.13	—	.13½
Citric, crystals	lb.	.72½	—	.73
Hydrochloric, commercial, 18 deg	lb.	.01⅛	—	.01½
Hydrochloric, 20 deg	lb.	.01½		.01¾
Hydrochloric, C. P., conc., 22 deg	lb.	.01¾	—	.01¾
Hydrofluoric, 30 per cent., in 1 barrels	lb.	.04¾	—	.05
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.04½	—	.05
Nitric, 36 deg	lb.	.07¼	—	.07½
Nitric, 42 deg	lb.	.08	—	.08¼
Oxalic, crystals	lb.	.15	—	.16
Phosphoric, 85 per cent	lb.	.33		.37
Picric	lb.	.70		.75
Pyrogallic, resublimed	lb.	3 50	—	4 00
Sulphuric, 60 deg	ton	22 00		24 00
Sulphuric, 66 deg	ton	29 00	—	30 00
Sulphuric, oleum (Fuming), tank cars	ton	38 00		40 00
Tannic, U. S. P., bulk	lb.	.45	—	.50
Tartaric, crystals	lb.	.79	—	.81
Tungstic, basis 100 per cent	lb.	1 80	—	
Alcohol, grain, 188 proof	gal.	3.84	—	3 86
Alcohol, wood, 95 per cent	gal.	1 00	—	1.02
Alcohol, denatured, 180 proof	gal.	1 00	—	1.02
Alum, ammonia lump	lb.	.04¼		.04¼
Alum, chrome ammonium	lb.	.19	—	.20
Alum, chrome potassium	lb.	.30		.32
Alum, chrome sodium	lb.	.12	—	.12½
Alum, potash lump	lb.	.07½		.08
Aluminium sulphate, technical	lb.	.02	—	.02½
Aluminium sulphate, iron free	lb.	.03		.03¼
Ammonia aqua, 26 deg. carboys	lb.	.07	—	.07½
Ammonium carbonate	lb.	.13	—	.14
Ammonium nitrate	lb.	.16	—	.17
Ammonium, sulphate domestic	100 lb.	6 25	—	6 35
Amyl acetate	gal	1 50	—	1 60
Arsenic, white	lb.	.17	—	.18
Arsenic, red	lb.	.50		.60
Barium chloride	ton	80 00	—	90 00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.10½	—	.11
Barium peroxide, 80 per cent	lb.	.27	—	.27½

Bleaching powder, 35 per cent chlorine	lb.	.01½		02
Borax, crystals, sacks	lb.	.07¾		08
Brimstone, crude	ton	45 00		
Bromine, technical	lb.	80		90
Calcium, acetate, crude	lb.	03		03½
Calcium, carbide	ton	80.00	90	00
Calcium chloride, 70-75 per cent, fused, lump	ton	26.00	28	00
Calcium peroxide	lb.	1.60	1	65
Calcium phosphate	lb.	.30		.31
Calcium sulphate	lb.	.10		.12
Carbon bisulphide	lb.	.04¼		04½
Carbon tetrachloride, drums	lb.	.16		16½
Caustic potash, 88-92 per cent	lb.	.83		.85
Caustic soda, 76 per cent	lb.	.07½		07¾
Chlorine, liquid	lb.	.15		.18
Cobalt oxide	lb.	1 55	1	60
Copperas	100 lb.	1 00	1	05
Copper carbonate	lb.	.30		.32
Copper cyanide	lb.	.72		.74
Copper sulphate, 99 per cent, large crystals	lb.	.09¼		09¾
Cream of tartar, crystals	lb.	.48		.49
Epsom salt, bags	100 lb.	1 25	1	50
Formaldehyde, 40 per cent	lb.	.17		.18
Glauber's salt	100 lb.	.70		.75
Glycerine, bulk, C. P.	lb.	.62		.63
Iodine, resublimed	lb.	3 50		
Iron oxide	lb.	.02		.08
Lead, acetate, white crystals	lb.	.16		.17
Lead arsenate	lb.	.12¾		.13½
Lead nitrate	lb.	.17½		.18
Litharge, American	lb.	.08		.19
Lithium carbonate	lb.	1.02	1	05
Manganese dioxide, U. S. P.	lb.	.55		.60
Magnesium carbonate, tech.	lb.	.13½		.14
Nickel salt, single	lb.	.14		.14½
Nickel salt, double	lb.	.11		.12
Phosphorus, red	lb.	1.15	1	20
Phosphorus, yellow	lb.	2 25	2	30
Potassium bichromate	lb.	.35½		.36
Potassium bromide granular	lb.	1.00	1	05
Potassium carbonate calcined, 80-85 per cent	lb.	.70		.75
Potassium chlorate, crystals	lb.	.52		.54
Potassium cyanide, 98-99 per cent	lb.	2.20	2	25
Potassium iodide	lb.	2.80	2	92
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	350.00	360	00
Potassium nitrate	lb.	.31		.33
Potassium permanganate	lb.	4 00	4	10
Potassium prussiate, red	lb.	2 50	2	55
Potassium prussiate, yellow	lb.	.08	1	05
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	325.00	350	00
Rochelle salts	lb.	.37½		38½
Sal ammoniac, gray gran	lb.	.10		.11
Sal ammoniac, white gran	lb.	.15		.16
Sal soda	100 lb.	1 15	1	25
Salt cake	100 lb.	.90	1	00
Silver cyanide	oz.	.70		
Silver nitrate	oz.	.43½		
Soda ash, 58 per cent, light, flat	100 lb.	2 75	2	85
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	4	00
Sodium acetate	lb.	.09		.10
Sodium benzoate	lb.	4 00	4	50
Sodium bicarbonate, domestic	100 lb.	2.35	2	50
Sodium bicarbonate, English	lb.			
Sodium bichromate	lb.	.15½		.16
Sodium bisulphite, powd	lb.	.03½		.04
Sodium chlorate	lb.	.24		.26
Sodium cyanide	lb.	.55		.60
Sodium fluoride, commercial	lb.	.13		.14
Sodium hyposulphite	lb.	.01¾		.02
Sodium nitrate, refined	lb.	.06		06¼
Sodium nitrite	lb.	.45		.55
Sodium peroxide	lb.	.55		.60
Sodium phosphate (tri.)	lb.	.04½		.05
Sodium prussiate, yellow	lb.	.29½		30½
Sodium silicate, liquid—10 deg. Baume	100 lb.	1 50	1	65
Sodium sulphide, 30 per cent crystals	100 lb.	2.00	2	10
Sodium sulphide, 60 per cent, fused	100 lb.	3.00	3	50
Sodium sulphite	lb.	.03¾		07½
Strontium nitrate	lb.	.28		.30
Sulphur chloride, drums	lb.	.06		.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15		.40
Sulphur, flowers, sublimed	100 lb.	3 20	3	30
Sulphur, roll	100 lb.	2.55	2	60
Sulphur, crude	ton	45 00	50	00
Tin bichloride, 50 deg.	lb.	.19¾		20
Tin oxide	lb.	.64½		65
Zinc carbonate	lb.	.25		.27
Zinc chloride	lb.	.10¼		.11
Zinc cyanide	lb.	.50		
Zinc dust, 350 mesh	lb.	.18		.20
Zinc oxide, American process XX	lb.	.14¾		.15
Zinc sulphate	lb.	.06		06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.55		.60
Benzol, 90 per cent	gal.	.53		.55
Toluol, pure, water white	gal.	1.70	1	80
Xylol, pure, water white	gal.	.50		.55
Solvent naphtha, water white	gal.	.19		.23
Solvent naphtha, crude, heavy	gal.	.13		.16
Creosote oil, 25 per cent	gal.	.31		.33
Dip oil, 20 per cent	gal.	.29		.30
Pitch, various grades	ton	8 00	24	00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	1	10
Carbolic acid, crude, 50 per cent	lb.	.55		.60
Carbolic acid, crude, 25 per cent	lb.	.32		.35
Cresol, U. S. P.	lb.	.25		

Intermediates, Etc.

Alpha naphthylamine	lb.	.90	1	05
Aniline oil	lb.	.29		.31
Aniline salts	lb.	.34		.35
Anthracene, 80 per cent	lb.	.10		
Benzaldehyde	lb.	4.00	4	50
Benzidine, base	lb.	1.85	2	00
Benzidine, sulphate	lb.	1.55	1	60
Benzoic acid	lb.	4.00	4	50
Benzyl chloride	lb.	1.75	2	00
Beta naphthol benzoate	lb	9 00	10	00
Beta naphthol, sublimed	lb.	.73		75
Beta naphthylamine sulphonic acid	lb.	2 50		
Dichlor benzol	lb.	.14		.20
Dinitrochlorbenzol	lb.	.16		.18
Dimethylaniline	lb.	.58		.60
Diphenylamine	lb.	.95	1	00
H-acid	lb.	3 25	3	50
Metaphenylenediamine	lb.	1 70	1	75
Monochlorbenzol	lb.	.23		.24
Naphthalene, flake	lb.	.09¼		09½
Naphthionic acid, crude	lb.	1 50	1	75
Nitro naphthaline	lb.	.15		.50
Nitro-toluol	lb.	.50		.55
Ortho-amidophenol	lb.			
Ortho-toluidine	lb.	1 00	1	15
Para-amidophenol, base	lb.	5 00	6	00
Paranitraniline	lb.	1 10	1	15
Paraphenylenediamine	lb.	3 75	4	00
Para toluidine	lb.	1 90	2	00
Phenol, U. S. P.	lb.	.40		.42
Resorcin, technical	lb.	8 00	9	00
Resorcin, pure	lb.	14 00	15	00
Salicylic acid	lb.	1 35	1	15
Salol	lb.	1 85	2	00
Sulphanilic acid	lb.	.32		.33
Toluhn	lb.	3 00		
Toluidine-mixture	lb.	.75		.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.10		
Corning, Ohio	bbl.	2.40		
Somerset, Ky.	bbl.	2.20		
Wooster, Ohio	bbl.	2.18		
Indiana	bbl.	1.78		
Illinois	bbl.	1.92		
Oklahoma and Kansas	bbl.	1.70		
Caddo, La., light	bbl.	1.90		
Corsicana, Tex., light	bbl.	1.70		
California	bbl.	.98	1	29
Gulf Coast	bbl.	1 00		

Lubricants

Black, reduced, 20 gravity, 25-30 cold test	gal.	.13½		14
Cylinder, light	gal.	.21		26
Cylinder, dark	gal.	.18		.19
Paraffine, high viscosity	gal.	.29½		.30
Paraffine, .903 sp. gr.	gal.	.21½		.22
Paraffine, .865 sp. gr.	gal.	.18½		.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52		
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48		
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½		
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35		
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37		
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26		
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22		
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40		
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19		
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19		

Vegetable and Other Oils

China wood oil	lb.	16½		16¾
Cottonseed oil, crude	gal.	1.07		
Linseed oil, raw, cars	gal.	1 15		
Peanut oil, crude	gal.	1 15		
Rosin oil, first run	gal.	.36		
Rosin oil, fourth run	gal.	.66		
Soya bean oil, Manchuria	lb.	14½		
Turpentine, spirits	gal.	.43		

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38 00		40.00
Barytes, floated, white, domestic	ton	28.00	32	00
Beeswax, white, pure	lb.	.60		.65
Carnauba wax, flor	lb.	.53		
Casein	lb.	.19		.28
Chalk, light, precipitated, English	lb.	.03		.06
Feldspar	ton	8.00	12	00
Fuller's earth, powdered	100 lb.	1.00	1	50
Ozokerite, crude, brown	lb.	.60		.70
Ozokerite, American	lb.	.35		
Red lead, dry, carloads	lb.	.13		
Rosin, 280 lb.	bbl.	6 00		
Soapstone	ton	10.00	12	50
Talc, American, white	ton	10 00	13	00
White lead, dry	lb.	.11½		

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	45.00	50	00
Clay brick, second quality	per 1000	30 00		
Magnesite, raw	ton	30.00	35	00
Magnesite, calcined	ton	40.00	55	00
Magnesite, Grecian, dead burned	net ton	90 00		
Magnesia brick, Grecian, 9″x4½″x2½	net ton	140 00		
Silica brick	per 1000	50 00		

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.	ton	160 00		
Ferrochromium	lb.	Nominal		
Ferromanganese, domestic, delivered	ton	400 00	425	00
Ferromanganese, English	ton	200 00		
Ferromolybdenum, per lb. of Mo	lb.	4 50		
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200.00	225	00
Ferrosilicon, 50 per cent, contract	ton	100.00		
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.65		
Ferrovanadium, f.o.b. works	lb.	3.25	3	50

INDUSTRIAL
Financial, Construction and Manufacturers' News

Financial

New Companies

The Advance Chemical Company, Wilmington, Del., has been incorporated with capital of $1,000,000 to manufacture chemicals, etc. The incorporators are: M. L. Rogers, L. A. Irwin and Harry W. Davis, all of Wilmington.

American Foundry Company, Inc., Elizabeth, N. J., has been incorporated with a capital of $125,000 to conduct a foundry business. Incorporators are Mary T. McCarthey, Rahway; Morris Jegger, Otto Froebel, Elizabeth.

The Beaver Chemical Company, Inc., New York, has filed articles of incorporation with capital of $10,000 to manufacture chemicals, etc. The incorporators are H. and B. Lichtenberg and S. Fillin, all of New York.

The Brettler Sheet Metal Works, New York, has been incorporated with a capital of $10,000 to manufacture iron floor plates. B. Brettler, the principal incorporator, operates a metal working plant at 227 East 47th Street. A. and M. Brettler are the other incorporators.

Charleston Alloy Steel Company, Belle, W. Va., has been incorporated with a capital of $500,000 to manufacture iron, steel, manganese, coke, copper, lumber and other minerals. The incorporators are J. M. Payne, Berkeley Minor, Jr., J. F. Bouchelle, E. A. McCoy and G. F. Brennan, all of Charleston.

The Clarke-Kessler Company, Wickliffe, Ohio, has been incorporated with a capital of $250,000. Incorporators are H. W. Kessler, C. R. Kessler, G. W. Clarke, Edgar J. Tyler and J. M. Shallenberger.

The Clement Synthetic Gas & Chemical Co., Inc., New York City, N. Y., has been incorporated with a capital of $5,000 to manufacture chemical compounds, dyestuffs, airplanes, automobiles. Incorporators are L. Clement, R. T. Grogan, H. Boes, 119 E. 88th St.

Wm. M. Crelin & Co., Newark, N. J. has been incorporated with a capital of $100,000 to manufacture chemicals, oils, greases, etc.

The Crescent Rubber Corporation, Chicago, has been incorporated under Delaware laws and capital of $1,500,000 to manufacture rubber and rubber products. The incorporators are: F. R. Kelley, Elgin, Ill.; George H. Gilberda, and R. S. Hanford, of Chicago.

Cuban Air Reduction Corporation, New York City, N. Y., has been incorporated with a capital of $267,500 to manufacture oxygen, nitrogen and other constituents of oil. Incorporators are F. A. Huehk, J. B. Kilburn, C. F. Wicker, 60 Broadway.

The Cumberland Petroleum & Refining Company has been incorporated in Delaware with a capital of $1,000,000 to produce and market oil and petroleum. Incorporators are John F. Sever, Kansas City, Mo.; R. C. Clapp, U. S. Barr, Wichita, Kans.

The Delion Tire & Rubber Company, Trenton, N. J., has been incorporated under Delaware laws with capital of $3,500,000 to manufacture rubber goods of different kinds. The company has a plant on East State Street, and is now building two 1-story additions, about 50 x 100 ft. and 25 x 65 ft.

The Delta Iron & Furnace Company, Chicago, has been incorporated with Delaware charter and capital of $5,000,000 to operate iron properties. Richard H. Holden, John A. Massen and DeGroot Van Baekeman, all of Chicago, are the incorporators.

Dixie Chemical Corporation, Petersburg, Va., has been incorporated with a capital of $180,000. Incorporators are C. W. Stratford, president, New York; W. J. Sommers secretary-treasurer, Petersburg.

The Dural Rubber Company, Trenton, N. J., has been incorporated with a capital of $200,000 to manufacture rubber and other specialties. The company has acquired a site at Flemington, N. J., and plans for the immediate establishment of a plant for the manufacture of automobile tires, rubber goods for aircraft and aeroplane parts. Edgar H. Wilson, Trenton, is president. Other incorporators of the company are Newton A. K. Bugbee, James C. Tattersall, H. M. Voorhees and John G. Connor. Local offices have been established at Room 711 Broad Street Bank Building.

Durex Aniline Works, Inc., New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture dyes, paints and chemicals. Incorporators are S. E. Baer, H. M. and M. Toch, 329 West 86th Street.

Durham Paper & Pulp Company, Phillipsburg, N. J., has been incorporated with a capital of $125,000 to manufacture paper, paper materials, pulp, etc.

Edgewood Glass Company, Hamilton, Ill., has been incorporated with a capital of $125,000. Incorporators are W. A. Baybourne, E. F. Phillips, William Sinton, W. S. Phillips, Jacob Scheuton, F. A. French.

The Empire Smelting & Refining Company of Chicago have been granted a permit to do business in Texas, with a capital stock of $100,000, with headquarters at San Antonio and El Paso.

Freeport Chemical Company, Freeport, Tex., has been incorporated with a capital of $100,000 to manufacture sulphur products. Incorporators are Christian B. Sanbriskie, New York City; Christian De Guigno, Jr., Hillsborough, Cal.; George P. Howard and William A. Vinson of Houston.

Gillillan Bros. Smelting & Refining Co., Los Angeles, Cal., has been incorporated with a capital of $100,000. Incorporators are S. W. Gillilan, C. F. Gillilan, L. G. Brown, A. W. Klusmann and G. L. Alspach.

Greenback Mining & Smelting Company, Wilmington, Del., has been incorporated with a capital of $250,000 to conduct a general mining business.

C. H. Hall, Plainfield, N. J., has been incorporated with a capital of $25,000 to manufacture and deal in drugs, chemicals, etc. Incorporators are Charles H. Hall, Elizabeth T. Hall and Louis P. Wilson, Plainfield.

T. O. Horne Company, Pleasant Unity, Pa., has been incorporated with a capital of $10,000 to manufacture iron and steel. Incorporator, Mary E. Horne.

Indian Copper Company has been incorporated in Delaware with a capital of $100,000 to carry on business of reducing smelting and mining of gold, silver, copper, etc. Incorporators are Arthur W. Britton, Henry O. Coughlan, George V. Reilly, all of New York.

Independent American Oil & Sulphur Corp. has been incorporated in Delaware with a capital of $15,000,000 to acquire lands containing oil, natural gas, sulphur and other minerals, etc. Incorporators are A. M. Halloran, M. H. Morris, F. Giles, local, Wilmington, Del.

International Alcohol Corporation has been incorporated in Delaware with a capital of $4,000,000 to manufacture alcohol from sawdust, wood wastes and other substances. Incorporators are L. F. Rebori, Frank Cusick and A. Sheard, New York City.

The International Chemical Company, Washington, D. C., has been incorporated under Delaware laws with capital of $100,000 to manufacture chemicals and kindred products. The incorporators are William H. Forman, Thomas J. Hall, Washington, and Charles G. Guyer, Wilmington, Del.

I. G. Jones Co., Inc., Syracuse, N. Y., has been incorporated with a capital of $50,000 to manufacture engines, boilers, petroleum and products, chemicals, asbestos and fireproofing, electrical machinery, plumbers' supplies. Incorporators are I. G. Jones, H. L. Betts, F. C. Faulkner, Syracuse.

The Kaolin Refining Co., 608 Hyde Building, Spokane, Wash., has been incorporated with a capital of $100,000 by D. C. Neatus, Cyrus Rappa and John J. Kyle. The company owns a clay bank north of Spokane, near Deer Park, Wash., containing a large amount of kaolin and ochre. The kaolin analyzed 51.22 per cent silica, 33.52 per cent alumina, 1.72 per cent iron, traces of magnesia, 0.62 per cent alkali, 2.31 per cent fluxes, 1.38 per cent moisture. Loss on ignition, 11.26 per cent. The company intends to build a mill of 30-ton capacity. The mill will be equipped with a flotation plant to separate the grit from the kaolin.

Kenwood Oil Corporation has been incorporated in Delaware with a capital of $10,000,000 to acquire lands containing oil, coal and iron and develop same. Incorporators are A. M. Halloran, M. H. Morris, Ferris Giles, Wilmington, Del.

The Lake Shore Chemical Co., Cleveland, Ohio, has been incorporated with a capital of $200,000. Incorporator, Francis Seiberling.

The Landon Corporation, South Bend, Ind., has been incorporated with a capital of $350,000 to manufacture chemicals and chemical compounds. Incorporators are Georgia V. Landon, Lewis C. Landon, Carl S. Ayres.

The Lignistra Fibre Products Co., Barberton, Ohio, has been incorporated with a capital of $150,000. The incorporator is Kenneth S. Smith.

Linden Chemical Company, Linden, N. J., has been incorporated with a capital of $125,000 to manufacture and deal in chemicals. Incorporators are Adam J. Traub of Elizabeth and Norman W. Kempf and Louis A. Kempf of Newark.

Lippincott Chemical Company, Inc., New York City, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals, drugs, compounds, etc. Incorporators are W. A. Lippincott, Great Neck, L. I.; B. Berkow, 524 West 34th Street, J. F. Russell, Jr., 43 Cedar Street, New York City.

The Metallograph Corporation, New York, has filed articles of incorporation with capital of $540,000 to operate a refining works for brass, copper and other metals. The incorporators are I. M. Berliner, F. Spungin and J. J. Cohen, 135 West 115th Street.

National Castings Company, Carlisle, Pa., has been incorporated with a capital of $50,000 to manufacture iron and steel. Incorporator: J. H. Foreman, treasurer.

Newcomb Iron & Steel Company, New York, has been incorporated with a capital of $10,000 to manufacture railway equipment. Incorporators are Albert C. Smith, Paul V. Hoyler, Irving H. Schafer.

The Philadelphia Wax Paper Company, Philadelphia, Pa., has been incorporated with a capital of $150,000 to operate a local plant. S. W. Stanage is the principal incorporator.

The Allen W. Phillips Smelting Company has been incorporated with a capital of $50,000 to manufacture steel. The incorporators are Allen W. Phillips, president; Charles Bloss, treasurer, and Dr. Louis Millet, secretary, and others.

The Prestotite Company, Wilmington, Del., has been incorporated with a capital of $50,000 to manufacture and sell "Prestotite" and other chemical compounds.

Radcliffe Color & Chemical Works, Elizabeth, N. J., has been incorporated with a capital of $50,000 to manufacture and deal in colors and dyes. Incorporators are David D. Radcliffe, John J. Smith, Elizabeth; John H. Strawbridge, Hillside Township, Union Cunty.

Rahway Chemical Manufacturing Company, Rahway, N. J., has been incorporated with a capital of $25,000 to manufacture chemicals. Incorporators are I. S. Joseph, G. H. Adler, J. B. Eiseman, Rahway.

The Refractory Magnesite Corporation, New York, has been incorporated in Delaware with capital of $100,000 to operate copper, manganese iron and other ore properties. Arthur W. Britton, Louis H. Gunther and Joseph F. Curtin, all of New York, are the incorporators.

The Rhode Island Foundry & Machine Company, Providence, R. I., has been incorporated with a capital of $100,000. Incorporators are Henry S. Chaffee, Dwight K. Bartlett and Samuel Raynor.

Rockford Union Foundry Company, Rockford, Ill., has been incorporated with a capital of $25,000. Incorporators are Hugo L. Olson, W. A. Brolin, Shelby L. Large.

Rom-Baw Chemical Co., Inc., Clinton, N. Y., has been incorporated with a capital of $25,000 to manufacture furniture polish, varnishes and chemicals. Incorporators are G. H. and M. E. Allen, E. D. Hunter, Clinton.

Sanlis Valley Land & Mining Company, Philadelphia, Pa., has been incorporated with a capital of $3,000,000 to engage in a general mining, milling and refining of ores. Incorporators are F. R. Hansell, J. Vernon Fimm of Philadelphia, and S. C. Seymour, Camden, N. J.

The Stamping Products Corporation, New York, has been incorporated with a capital of $25,000 to manufacture metal molds, etc. C. A. Anderson, S. B. Sherman and G. C. Steeves, 630 West 141st Street, New York, are the incorporators.

The Stanley Vehicle Spring Company, Syracuse, N. Y., has filed articles of incorporation with capital of $100,000 to manufacture steel springs of different kinds. F. W. Green, W. H. Robinson and H. P. Denison, all of Syracuse, are the incorporators.

Sterling Refining Company, Evansville, Ind., has been incorporated with a capital of $10,000 to manufacture sugar, candies and kindred products. Incorporators are Charles F. Hartmetz, Henry A. Wimberg, George P. Stocker.

The Taylor Turpentine Company, Mobile, Ala., has been incorporated with a capital of $100,000. Incorporators are S. and A. Lowenstein and Thos. J. Taylor, H. C. Taylor.

The Texas Production Company has been incorporated under Delaware laws with capital of $1,000,000 to operate oil properties. M. H. Morris, A. M. Halloran and Ferris Giles, Wilmington, are the incorporators of the company.

Texas Sulphur Royalty Company, Wilmington, Del., has been incorporated with a capital of $50,000 to acquire mining claims and develop same. Incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del., Clement M. Egner, Elkton, Md.

Thomas & Betts Co., Elizabeth, N. J., has been incorporated with a capital of $300,000 to act as merchants and deal in chemicals. Incorporators are Robert McK. Thomas, Meandham; Hart D. Betts, Englewood, Adnah McMurtrie, New York City.

Virginia Chlorine Products Corp. has been incorporated in Delaware with a capital of $1,500,000 to manufacture all kinds of dyes, chemicals, etc. Incorporators are C. J. Kulberg, New York; H. Van Arsdale, Newark, N. J.; D. A. Woodcock, Passaic, N. J.

Warren Products Co., Inc., New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture chemicals and drugs. Incorporators are F. L. Cramer, D. K. Hill, H. R. Harrison, 120 Broadway.

The Wilson Oil & Gas Company, Zanesville, Ind., has been incorporated with a capital of $9,000 to sink and operate oil and gas wells. Incorporators are Charles I. Weirich, J. A. Prough, Jasper C. Middaugh, John Miller, James L. McBride.

Wonder Paper & Fabric Company has been incorporated in Delaware with a capital of $2,100,000 to manufacture and sell paper of all kinds. Incorporators are Herbert E. Latter, Henry Robinson, Wilmington, Del., and Clement M. Egner, Elkton, Md.

O. W. Young, Inc., Newark, N. J., has been incorporated with a capital of $25,000 to manufacture and deal in lubricating and illuminating oils. Incorporators are Joseph T. Davey, Kate F. Montrose, Patrick A. Blewith, Newark; Clarence H. Smith, Linden.

Changes of Ownership, Capital, Increases, Etc.

Harrisons' Incorporated, paint manufacturers of Philadelphia, recently purchased by E. I. du Pont de Nemours & Co., have just completed an important purchase which rounds out their business and gives them control of colors and chemicals needed in the manufacture of paint which they have hitherto purchased from other producers. This deal involves an expenditure of about $2,000,000 and gives the Harrison Company control of the Beckton Chemical Company, with plants in Newark, N. J., and in Philadelphia, and of Canby Clark & Co., with plants in Newark, N. J. The Beckton Company was controlled by Canby Clark & Co., and the purchase by Harrisons' Incorporated, includes the stock of both companies. Canby Clark & Co.'s factories manufacture colors for paints, paper, ink, etc., as well as chemicals used in the paint industry. The Beckton Company is a large producer of acids and lithopone.

The American Briquette Company, Philadelphia, Pa., has increased its capital from $25,000 to $200,000 for expansion.

The United States Metals Reduction Company, Pittsburgh, Pa., a Delaware incorporation, has increased its capital from $100,000 to $300,000 to provide for business extensions.

The Fiske Brothers Refining Company, 24 State Street, New York, has increased its capital from $100,000 to $500,000.

The Essex Rubber Company, May and Beakes streets, Trenton, N. J., manufacturer of mechanical rubber goods, has increased its capital from $500,000 to $700,000.

The Simpson Gasoline Company, Bradford, Pa., has increased its capital from $95,000 to $200,000 for expansion.

The Shields Oil & Gas Company, Pittsburgh, Pa., a Delaware incorporation, has increased its capital from $50,000 to $100,000 for extensions.

The Iroquois Foundries, Utica, N. Y., has increased its capital from $25,000 to $75,000 to provide for business extensions.

Construction and Operation

Alabama

BIRMINGHAM.—The United States Steel Corporation has appropriated $11,000,000 for extensions to the plant of the Tennessee Coal, Iron & Railroad Company at Birmingham. The extensions will be used for manufacturing products of commercial use at the present time.

MOBILE.—Several veneer plants have been established recently in the southern part of the State. A new plant will be finished at Ellisville and similar one at Jeffris, La., across the river from Natchez.

Arizona

JEROME.—Actual work on the construction of the United Verde Extension smelter is under way. It is understood that there has been a reversal of the plans for driving a two-mile tunnel and that for some time the ore will continue to be hoisted and delivered to the railroad through a service tunnel at a much higher level. On account of the strike the May output was cut down about 1,000,000 lb. The shortage of production for June will probably be 1,700,000 lb. from the same cause.

Arkansas

LITTLE ROCK.—The Arkansas Lime Company is planning the erection of a $25,000 plant to grind glass sand. The erection of several glass factories at Fort Smith has created a demand for this product.

California

BERKELEY.—The Philadelphia Quartz Co. of Philadelphia has recently incorporated under the California laws and will manufacture silicate of soda in a new plant which will be built here.

MARTINEZ.—The Theodore Dittell Company has commenced erection of a glass-sand, silica and clay refining plant near Antioch. The company will refine glass sand and china clay.

SAN FRANCISCO.—The Amalgamated Paint Co. of New York, manufacturer of marine paint, will establish a Pacific Coast plant to be located on San Francisco Bay.

Colorado

RENO.—Mr. J. C. Moore of New York, together with two engineers, is investigating the possibilities of extracting potash from the waters of Lakes Sumner and Abert, near Lakeview. It is understood that a plant will be erected. A branch railroad will be constructed to connect with the Western Pacific.

Delaware

WILMINGTON.—The Standard Kid Mfg. Company, recently incorporated, has commenced the operation of a plant on Monroe Street for the manufacture of glazed kid and kindred leather specialties. The company has a capitalization of $12,000. The officers, formerly associated with F. Blumenthal & Company, Wilmington, are R. C. McMullen, vice-president, and P. A. Monigle, secretary.

Georgia

SAVANNAH.—The new plant of the Savannah Sugar Refining Company was recently put in operation. The refinery has a capacity of 150,000 tons of sugar annually and is the only one between Philadelphia and New Orleans. The directors are Henry T. Oxnard, Robert Oxnard, James Imbrie, Mills B. Lane, J. H. Hunter, B. A. Oxnard.

Idaho

COEUR D'ALENE.—It is reported that the Coeur d'Alene Mining Company has uncovered 8 ft. of high-grade antimony ore at its Fine Creek property, said to be the largest body of antimony ever uncovered in Idaho. Of the ore fully 3 ft. is first-class shipping product and balance is mill feed free from impurities.

KELLOGG.—Ore to be used in the initial charge of the $1,000,000 smelter of the Bunker Hill & Sullivan has reached the plant, and it is expected that the smelter will begin operations in the very near future. Every section of the big plant is built so that an increase in capacity can be made with the least expense and briefest expenditure of time. The first ore to be treated will be that produced by the company mines, but the opening of the plant to custom trade will make necessary an early expansion. The plant will be in charge of M. H. Sullivan, former assistant superintendent of the Trail Smelter of the Consolidated Mining & Smelting Company, who has had charge of construction of the plant. The company has announced that, effective June 1, all employees of the Bunker Hill & Sullivan smelter were granted a bonus of 75 cents a day. About 3000 smelter employees are affected.

NEZ PERCE.—The plant of the Nez Perce Brick & Tile Factory will begin operations at once. Work of installing machinery has been completed.

Maryland

BALTIMORE.—The Penn-Mary Steel Company is taking bids for the erection of a new one-story concrete copper shop, about 60 x 121 ft.

Michigan

MONROE.—The Monroe Chemical Company will occupy temporarily part of the old Monroe Glass Company for the manufacture of chemicals. The company is a new one.

Montana

BUTTE.—Considerable difficulty is being experienced in the mining district adjacent to Butte by partial strikes at the various properties. The Davis-Daly copper mine, Anaconda Copper Company, the Elm Orlu property, and a number of others have been affected. No disorders of any kind marked the strike, and a number of the men have returned to work.

LIVINGSTON.—H. A. Bacorn and associates have plans under way for the mining of sheelite in Park County. The company plans to immediately open the tungsten and gold mines at Jardine.

New Jersey

BAYONNE.—The National Sulphur Company has awarded a contract for the erection of a two-story reinforced-concrete addition to its plant to cost $20,000. The H. D. Best Company, 52 Vanderbilt Avenue, New York, are the contractors.

BOGOTA.—The Federal Paper Board Company has awarded a contract for the erection of a one-story brick addition to its plant on the River Road.

ELIZABETH.—The Linden Tanning Company, leather manufacturer, is planning the erection of an addition to its plant which will cost $250,000.

HARRISON.—The Crucible Steel Company, South Fourth Street, will build a new one-story shop building about 200 x 400 ft., to be used for forging work. The company will also build a new steel mill in the Lawrenceville district, near Pittsburgh, Pa., to cost about $125,000.

JERSEY CITY.—The Seydel Manufacturing Co.'s plant in which aniline dyes and chemicals were made was destroyed by fire several days ago at a loss of $150,000. A huge pot of benzoic acid boiled over during the fire and caused a great deal of confusion among the workingmen leaving.

NEWARK.—The Alcohol Products Company has had plans prepared for a new plant at the foot of Blanchard Street to cost about $75,000, for the manufacture of alcohol and chemcal specialties. The structures will include a main refining works to be two stories, reinforced-concrete, about 62 x 85 ft., one-story building, 40 x 40 ft., and engine and boiler house for plant operation, 32 x 35 ft. Frederick A. Phelps, Union Building, is architect.

NEWARK.—The Universal Smelting & Refining Company will build a new one-story, brick and steel plant, 110 x 450 ft., at 154 St. Charles Street, to cost about $154,000. The plant will be used for the production of tin, lead, etc. Plans for the erection have been filed.

NEWARK.—The American Leather Mfg. Company, 488 Frelinghuysen Avenue, has filed plans for the erection of two one-story additions to its plant at New and Nuttman Streets, about 25 x 45 ft., and 11 x 35 ft., respectively.

NEWARK.—The Dooner & Smith Chemical Company, 258-60 New Jersey Railroad Avenue, has filed plans for the construction of a one-story addition to its plant, about 50 x 86 ft.

NEWARK.—H. F. Sommer & Company, 219 Hamburg Place, manufacturer of leather, has filed plans for the erection of a new one-story tannery addition.

NEWARK.—The General Alloy Company, 59 Bruen Street, has filed notice of organization to operate a local plant for the production of different alloys. Davis Rosen is head.

NEWARK.—J. L. Armitage & Company, 51 Dawson Street, manufacturer of paints and varnishes, will build a one-story reinforced-concrete addition to its plant, about 30 x 60 ft.

NEWARK.—The Celluloid Company has filed plans for the erection of a one-story addition to its plant, about 30 x 69 ft., at 51 Westcott Street.

RIDGEFIELD PARK.—The Bergen Paper Company will build a two-story addition to its plant, about 60 x 85 ft., to cost $15,000.

New York

LEROY.—The LeRoy Electric Porcelain Company will increase the capacity of its plant for the manufacture of electric porcelain specialties. Four new kilns will be erected.

LOCKPORT.—The Lockport Paper Company, Mill Street, manufacturer of paper, will build a one and two-story reinforced-concrete addition to its plant, about 40 x 110 ft. Harry Nichols is general manager.

LOCKPORT.—The Simonds Mfg. Company, Ohio Street, manufacturer of saw steel, will build a one-story extension to its plant, about 55 x 165 ft.

WATERTOWN.—The Brownsville Paper Company will erect a large addition to its plant this summer.

Ohio

CINCINNATI.—A company to be known as the Elferose Sugar Company has been formed for making a special kind of sugar and syrup not now attainable in the United States. J. W. Freiberg of the Freiberg & Workum Company, is interested.

Oregon

OREGON CITY.—A strike of 100 employees of the Crown-Willamette Paper Company, resulting in complete close-down of the mills, has been settled satisfactorily. Coincident with the settlement the company announced a bonus of 50 cents a day for all its employees, effective June 1. New bonus takes the place of a graduated bonus of from 50 to 25 cents, based on the wage rate of the employee, which has been in force for some time.

ROSEBURG.—Charles W. Jones of Portland, expects to establish a fertilizer plant on the property of the Oregon-Portland Cement Company near Roseburg. It is said the property contains an unlimited supply of lime rock suitable for manufacture of farm products, and a plant costing $100,000 is to be installed.

Pennsylvania

EASTON.—The Standard Processing Steel Corporation has increased its capital from $300,000 to $500,000 for expansion. It is proposed to increase the capacities of the present steel and iron foundries; the output of the latter department will be doubled. The work is estimated to cost $100,000. O. L. Mills is president.

PHILADELPHIA.—The Penn Chemical Company has awarded a contract for the erection of a three-story brick and concrete addition, about 25 x 50 ft., on Washington Avenue. The new works, with power house, will cost $75,000.

PHILADELPHIA.—J. F. Johnson & Company, operating automobile repair shops at 2317 North Sixteenth Street, are taking bids for the construction of a new two-story garage and tool shop, 30 x 115 ft., at Ninth and Tioga Streets.

PHILADELPHIA.—C. F. Simonin's Sons, Tioga and Belgrade Streets, manufacturers of oils, etc., have awarded a contract for the erection of a one-story addition, about 75 x 90 ft., to cost $15,000.

PHILADELPHIA.—Fire recently destroyed a portion of the plant of the Barrett Manufacturing Company, Tucker and Bermuda Streets, with loss estimated at $10,000. The plant will be rebuilt.

PHILADELPHIA.—The Crew Levick Company, Land Title Building, manufacturer of oils, has commenced the preparation of plans for its new oil plant to be located on Pettys Island in the Delaware River, opposite Philadelphia, to comprise about ten buildings. This company is one of the properties of Henry R. Doherty Company, 60 Wall Street, New York.

PHILADELPHIA.—The India Refining Company, Swanson and McKean Streets, manufacturer of refined oils, has filed plans for the erection of an addition to cost about $25,000.

PITTSBURGH.—The Knox Pressed & Welded Steel Company of Wheatland and the Blaw Steel Company of Pittsburgh have combined. The new firm is to be known as the Blaw-Knox Steel Company and will be capitalized at $1,400,000. The Blaw company has a large plant in Pittsburgh, where it manufactures steel and copper and other products. The Knox plants are located in Sharon and Wheatland.

PITTSBURGH.—The Damascus Bronze Company, 929 South Avenue, manufacturer of brass and bronze castings babbitt metal, etc., has filed plans for a new one-story foundry on Reedsdale Street to cost about $25,000.

WARREN.—The Warren Oil Company has acquired about ten acres of property near the city and plans for the construction of a new oil and blending works to cost about $50,00.

Tennessee

CHATTANOOGA.—The Chattanooga Gas & Coal Products Company will increase the capacity of its coke manufacturing plant at Alton Park by the installation of 24 new ovens, at an estimated cost of about $300,000. The plant will have a capacity of about 300 tons of coke daily. The Semet-Solvay Company, Solvay, N. Y., has the contract for erection.

Utah

SALT LAKE CITY.—A new company known as the Western Phosphate Mining & Manufacturing Company, will locate a plant near Paris, Idaho., in a field of phosphate rock.

Virginia

LYNCHBURG.—The Glamorgan Pipe Foundry Company has awarded a contract for the erection of an addition to its plant, about 40 x 80 ft., to cost $20,000.

NEWPORT NEWS.—The War Department has awarded a contract for the construction of a large manufacturing plant to make hydrogen for balloons. The gas will be made at the Government aviation station.

Washington

EVERETT.—The Western Talc Company here recently began work of opening a large body of talc near Reardan, Wash. The company will begin shipping as soon as machinery for the mill has been installed.

MORTON.—A. R. Rutherford, here, announces that the group of cinnabar mines near Morton have been sold to a new concern and that a large crew of men will be put at work immediately to reduce the immense quantity of low-grade ore in sight to quicksilver.

SPOKANE.—The Humane Stock Remedies Company here will immediately rebuild its lime-sulphur solution plant which was destroyed by fire on May 17, the new plant to have a capacity double that of the old one. The company will also build and equip a large new furnace room.

SPOKANE.—Northwestern Magnesite Company of Spokane has awarded a contract for the construction of a tramway 25,000 ft. long. The net fall is 430 ft. and the capacity 60 tons per hour. The tramway will deliver magnesite from the company's properties to their mill near Chewelah, Wash. The tramway will be built by the Riblet Tramway Comany, who will also build a tramway for the Engels Copper Mining Company of Engels, Cal.

TACOMA.—By combining two small plants and doubling the stock and number of workmen employed, S. Menefee, manager of W. P. Fuller & Company here, has created the largest plant in the Northwest for the manufacture of mirrors, art glass and bevel plate. The two plants consolidated are the Myhern Company and Destiny Art Glass Works, both on A Street, Tacoma. The enlarged plant has been located in the Ferguson Building at 1205 A Street, and will be known as Fuller's Art Glass, Mirror & Bevel Plate Works, a branch of W. P. Fuller & Co.

West Virginia

CLARKSBURG.—Many new companies are coming to West Virginia for coal in spite of the natural gas shortage. The shortage of natural gas in several other States has caused industrial companies to pick locations where coal is readily available.

WHEELING.—The Hazel-Atlas Glass Company plans another addition to its plant.

British Columbia

AINSWORTH, B. C.—The concentrates of the Silver Hoard mine here are running high, according to report of W. S. Hawley of Spokane. Concentrates show 65 per cent lead, 150 ounces in silver and 45 per cent zinc. As soon as machinery is adjusted it is expected this can be raised to 70 per cent lead and 50 per cent zinc, with a recovery of 85 to 90 per cent. The flotation plant will begin operation July 1.

KAMLOOPS, B. C.—The local board of trade has approached the Provincial Government for the construction of a smelter in this district for the treatment of low-grade ores. The Minister of Mines announces that it is not the intention of the government to erect any smelters in 1917, but the claims of Kamloops will be investigated.

NELSON.—The Molly Mine, next to the largest molybdenite mine in Canada, is to be immediately equipped with a large mill. Figures show that the mine ranks second as the largest producer of molybdenite and one of the most important of the country's munition properties.

NEW WESTMINSTER.—The Western Canada Lime Company has achieved considerable success since its opening. Plant has been handicapped by lack of available labor, but its product, pulverized lime rock, has been very popular.

PENTICTON.—The Canada Copper Corporation, Mr. Ashmund, general manager, is completing plans for equipping the mine at Copper Mountain for a production of 2,000 tons daily; installation of a power plant, and mill capable of handling this tonnage. About 600 employes will ultimately be required. Mill will be built on the Similkameen River and the oil flotation process will be used.

PORT COQUITLAM.—Voters will shortly pass on a by-law to be submitted to them to bonus the proposed steel works plant to the extent of $200,000, of which A. F. Bernstein of Vancouver, and associates, will be the founders. The proposition is that the Steel Company shall spend $800,000 in the establishment of a plant to turn out 75 tons of steel daily.

TRAIL.—In spite of lack of coke, shortage of labor, high costs of operation and other difficulties, the big smelter and refinery here has continued to handle ore. During the last week in May 5669 tons of ore were received at the smelter. The total for the month of May, however, dropped to 15,364 tons, the lowest of any month during the year.

TRAIL.—It is expected that the new concentrator of the Consolidated Mining & Smelting Company here will be completed. The equipment of machinery installed, and the plant in operation. Wilfley tables and other machines are now being placed and arrangements made for using the oil flotation process in the concentration of the company's Sullivan mine complex ores, for which the plant is primarily intended. The plant will have capacity of 200 tons daily, and is erected as an experimental plant. If successful, a much larger plant will be erected.

VANCOUVER.—One unit of the Pacific Mills, Ltd., at Ocean Falls, capable of producing 75 tons of newspaper stock daily, has been put into operation. This plant is the first unit of an ultimate development of 195 tons.

VANCOUVER.—Hematite Mining Company has been reorganized with capital stock of $45,000.

VANCOUVER.—The Canadian Collieries are building 150 coke ovens at Union Bay. It is expected that the Kootenay-Boundary smelters will be able to get some coke from the coast.

VANCOUVER.—The Rainy River Pulp & Paper Company has commenced manufacture of paper at its Port Mellon, Howe Sound mill, the first four units of the plant having begun operation. The plant was changed in record time from a soda process mill to a kraft process mill, having been bought by Eastern capitalists early in February. It is the only plant using the kraft process on the Pacific Coast.

VICTORIA.—Hon. William Sloan has introduced a bill in Legislature to permit the department of mines to go into the smelter business if warranted, urging its passage as a means of further developing the natural resources of the province.

VICTORIA.—The Hardy Bay Coal Company here has been organized with a capital stock of $1,000,000, with the object of acquiring, developing, operating, working and selling mines, mineral claims, mining properties and petroleum claims, and the treating, refining and marketing of mineral coal or oil therefrom.

Manufacturers' Notes

BRITISH REGULATION OF SULPHURIC ACID.—Important orders have been issued from the British Ministry of Munitions bearing the date of May 29, 1917, regulating, in all respects, the manufacture and sale of sulphuric acid. The order, according to *Commerce Reports*, says that

1. No person shall as on and from the 11th of June 1917, until further notice, manufacture sulphuric acid except under a license issued by or under the authority of the Minister of Munitions and in accordance with the terms and conditions of such license as to the quantities to be manufactured or otherwise.

2. No person manufacturing sulphuric acid shall as on and from the 11th of June, 1917, until further notice, use during any one calendar month more than 10 tons in all of 75 per cent sulphuric acid (or its equivalent in acid of other strengths) for the purpose of all other manufactures, trades and businesses carried on by him except under and in accordance with the terms and conditions of a license issued by or under the authority of the Minister of Munitions.

3. No person shall as on and from the day following the date of this order, until further notice, supply sulphuric acid (including waste sulphuric acid) to any person except under and in accordance with the terms and conditions of a license issued by or under the authority of the Minister of Munitions. Provided that no license shall be required to supply not more than 56 pounds of 95 per cent sulphuric acid (or its equivalent in acid of other strengths) to any person during any one calendar month. And provided also that any sulphuric acid supplied subsequently to the date of this order in pursuance of written directions or requests given or made by or on behalf of the Minister of Munitions previously to the date of this order shall, unless and until such written directions or requests are canceled or withdrawn, be deemed to have been supplied under a license issued under the authority of the Minister of Munitions within the meaning of this order.

The order also states that no manufacturer of sulphuric acid or agent of such a manufacturer shall charge or receive in payment for any sulphuric acid supplied by or through him a price exceeding a maximum specified in the order.

NATIONAL ANILINE & CHEMICAL COMPANY, INC., ELECTS OFFICERS.—The officers and directors of the new National Aniline & Chemical Company, chosen at the recent meeting, are as follows:

Chairman of the Board, William H. Nichols, president, J. F. Schoellkopf; first vice-president, William Beckers; second vice-president and treasurer, I. F. Stone; third vice-president, Hugo Schoellkopf, and secretary, William H. Miller. The directors are J. F. Schoellkopf, J. F. Schoellkopf, Jr., Hugo Schoellkopf, all of the Schoellkopf Aniline & Chemical Works, Inc.; William Beckers, Eugene Meyer, Jr., Charles J. Thurnauer of the W. Beckers Aniline & Chemical Works, Inc.; William H. Nichols, Henry Wigglesworth and J. M. Goetchius of the General Chemical Company and Benzol Products Company; T. M. Rainhard and W. N. Mellravy of Barrett Company and Benzol Products Company; H. H. S. Handy and E. L. Pierce of Semet-Solvay Company and Benzol Products Company. Mr. Meyer and Mr. Thurnauer also represent the firm or Eugene Meyer, Jr., & Co., and I. F. Stone the National Aniline & Chemical Company.

The capacity of the company will be more than 30,000,000 pounds annually, and expansions are going on rapidly. The offices have been at 244 Madison Avenue since July 1.

DU PONTS MAY ENTER DYESTUFF FIELD.—The Du Pont company is planning to enter the coal tar dye industry. The company has been investigating the dye situation for a long time. Its chemists were at work before the war, and when the foreign supply was cut off their efforts were redoubled. The Du Pont company has adequate laboratory facilities and large plants already equipped, so that delay for building operations is unnecessary.

VEGETABLE OIL INDUSTRY OF UNITED STATES.—Director Samual L. Rogers of the Bureau of the Census has issued a summary showing the production in the United States of edible vegetable oils other than cottonseed for the calendar year 1916.

There were received reports of 112 concerns in the United States in 1916 which manufactured 262,558,661 lb. of oil from peanuts, mustard seed, kapok seed, rape seed, sunflower seed, soya beans, walnuts, corn, copra, palm kernels, and olives. The movement to grow soya beans, peanuts and other oil-bearing seeds and nuts other than cottonseed for the manufacture of oil has received a great impetus and there will probably be several hundred establishments engaged in crushing the crops grown in 1917.

In addition to the production of home vegetable oils, which may be used for edible purposes, considerable quantities are also imported. During the calendar year 1916 there was imported 64,349,308 lb. of cocoanut oil, 16,587,755 lb. of cottonseed oil, 145,469,289 lb. of soya-bean oil, 295,270,663 lb. of palm oil, 1,323,737 lb. of palm-kernel oil, 2,089,801 gal. of peanut oil, 2,690,755 gal. of rape-seed oil, 7,686,593 gal. of Chinese-nut oil, and 5,815,578 gal. of edible olive oil. During the same period there was exported 188,213,816 lb. of domestic cottonseed oil, and 9,118,812 lb. of corn oil; also 478,438 lb. of foreign cocoanut oil, 3,062,900 lb. of soya-bean oil, 46,805 lb. of palm oil, 22,780 gal. of peanut oil, and 52,265 gal. of edible olive oil.

TO ASSURE SUPPLIES OF PALM OIL.—A meeting was held at the Bureau of Foreign and Domestic Commerce in Washington last week which was attended by representatives of the tin-plate makers, soap makers, and palm oil importers, to arrange for an ample supply of palm oil for American industries.

A committee will be formed and the palm oil will be shipped direct from the west coast of Africa to the United States, instead of first going to England. In return for permitting exportation of oil, Great Britain is to receive its equivalent in glycerine content, which is 6 per cent.

THE GREAT WESTERN SMELTING & REFINING COMPANY of St. Louis has opened a Denver office at 312 Century Building, Denver, Col., their representative being Maxwell M. Levy. Orders will be taken from the Denver office and the shipments made either from the Chicago or St. Louis plants. The products offered by this company are: Babbitt, solder, pig lead, tin, antimony, copper ingot, brass ingot, aluminum ingot, phosphor tin, phosphor copper, stereotype, linotype, electrotype and monotype.

SODIUM NITRATE.—Marden, Orth & Hastings Company, Inc., of 61 Broadway, New York, are sole selling agents of the American Nitrogen Products Company, who are making sodium nitrate by the fixation of atmospheric nitrogen.

NEW CHICAGO RESEARCH LABORATORY.—The Research Laboratory of Chicago has recently been incorporated. This is an Illinois corporation, having a stock of $50,000. It is organized for the purpose of carrying on research work in the development and exploitation of chemical processes. The company also expects to engage in the manufacture of some pharmaceutical and photographic chemicals. The incorporators are W. S. Shaw, H. McCormack, A. G. Wackenreuter of Chicago, George S. Rice of Petosky, Mich.; F. S. Howse of Boston, and E. C. Klipstein of New York. Mr. Klipstein is president of the company, and Mr. McCormack will act as manager.

CARLISLE, PA., WANTS CHEMICAL INDUSTRIES.—Manufacturers about to enter the chemical field for the manufacture of dyes and other chemical products will be interested in an announcement received from the Carlisle Chamber of Commerce. Carlisle, Pa., that their city is making a very strenuous effort to secure the location of desirable chemical enterprises. The peculiar atmospheric conditions existing in Carlisle have been determined by expert engineers employed by the Chamber of Commerce as adaptable in every respect for the chemical industry.

In addition to the natural facilities, free factory sites, financial assistance, and a very low electric rate of $.011 per k.w.h. one of the lowest rates in the State of Pennsylvania, competent employees of all grades can be secured in Carlisle, and with its location, Baltimore Freight Classification, situated on two railroads, is one of the most advantageously located cities for distribution of chemicals in southeastern Pennsylvania.

NEW ELECTRIC FURNACE COMPANY.—The Booth-Hall Company has been formed to conduct an electric furnace building, engineering and metallurgical business with offices at 565 West Washington Blvd., Chicago. The new company is composed of five former officers and employees of the Snyder Electric Furnace Company. Mr. C. H. Booth, formerly president of the Snyder Electric Furnace Company, Chicago, will be president and general manager of this new company. Mr. W. K. Booth, formerly vice-president of the Snyder Electric Furnace Company, and who for many years was in charge of the engineering and metallurgical work for that company, is to be metallurgist for the new company. Mr. Julius R. Hall, formerly secretary, mechanical engineer and production manager of the Snyder Electric Furnace Co., will be vice-president of the new company and have charge of similar work for them. Mr. Hall was for many years designing engineer of the Strauss Bascule Bridge Company, Chicago. Mr. W. D. Walker, formerly sales manager of the Snyder Electric Furnace Company, will be sales manager of the new company, and Mr. F. J. Sheldon formerly auditor of the Snyder Electric Furnace Co., will be secretary.

The company has applied for patents on an electric furnace to be called the Booth-Hall electric furnace. This will be designed in three different types to suit the metallurgical conditions of the individual customer and to operate either one, two or three phase, as will best work out in each case. It is the intention of the new company to make a special study of the needs of its customers, and to be in a position to recommend the type of equipment best suited for the work to be done.

Experience has shown that frequently a three-phase furnace will work to better advantage on certain grades of steel than single phase, and other times a simple single-phase type of equipment is to be preferred.

The company has already closed a contract for a four-ton, two-phase, Booth-Hall furnace, which is to be the first unit in a newly formed electric steel company.

THE INDUSTRIAL ELECTRIC FURNACE COMPANY, organized under the laws of the State of Indiana, has acquired the business of the Snyder Electric Furnace Company and the Snyder patents and designs of electric furnaces and processes. The directors of the new company are Charles B. Sommers, Stoughton A. Fletcher and Charles B. Fletcher of Indianapolis and F. Von Schlegell and F. T. Snyder of Chicago. The business organization is new and the company will start with a large engineering force and will take up the manufacture of electric furnaces for steel work, will enlarge the plant at Clearing both for electrometallurgical developments and for the commercial production of electric furnace products. Mr. Snyder, who will be interested in and associated with the new company as engineer and metallurgist, has had many years of experience in the electric furnace field. The executive officers of the company will be F. Von Schlegell, president, and Charles B. Fletcher. The offices of the new company will be at 53 West Jackson Boulevard.

Manufacturers' Catalogs

THE STIMPSON EQUIPMENT COMPANY, Salt Lake City, Utah, has issued an attractive catalog on the Janney flotation machine for the treatment of ores by the flotation process. This booklet describes two types of Janney flotation machines and is illustrated by diagrams of the machines showing the different parts and also machines installed in different plants.

THE UNION SWITCH & SIGNAL COMPANY, Swissvale, Pa., has issued Bulletin 87 describing its forge plant.

THE JAMES ORE CONCENTRATOR COMPANY, 35 Runyon Street, Newark, N. J., has issued Bulletin No. 1, Section A, describing its concentrating tables.

THE PREST-O-LITE Company, Indianapolis, Ind., has issued a new catalog describing its apparatus for oxy-acetylene welding and cutting.

Other New Publications

MOTOR GASOLINE; PROPERTIES, LABORATORY METHODS OF TESTING AND PRACTICAL SPECIFICATIONS. By E. W. Dean. This is a Bureau of Standards publication, Technical Paper, 166.

THE ACTIVATED SLUDGE PROCESS OF SEWAGE TREATMENT. By J. Edward Porter of the General Filtration Company, Rochester, N. Y. This book gives a bibliography of the subjects with brief abstracts, patents, news items, etc., compiled from current literature.

MAGNETIC AND OTHER PROPERTIES OF IRON-ALUMINUM ALLOYS MELTED IN VACUO. By Trygve D Yensen and Walter A. Gateward. This is Bulletin No. 95 published by the University of Illinois, Urbana Engineering Experiment Station.

LIST OF PUBLICATIONS OF THE DEPARTMENT OF COMMERCE AVAILABLE FOR DISTRIBUTION. The fifteenth edition of this book, issued May 8, 1917.

THE MINING INDUSTRY IN THE TERRITORY OF ALASKA DURING THE CALENDAR YEAR 1915. By Sumner S. Smith. Bulletin 142 issued by the Department of the Interior, Bureau of Mines.

THE COAL-FIELDS AND COAL INDUSTRY OF EASTERN CANADA. By Francis W. Gray. Bulletin No. 14, published by the Canadian Department of Mines, Ottawa.

ANNUAL REPORT OF THE MINERAL PRODUCTION OF CANADA DURING THE CALENDAR YEAR 1915, published by the Canadian Department of Mines, Mines Branch, Ottawa.

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On the Progress of the War

One of the most popular "indoor sports" of the season seems to be criticizing the activities, or lack of activities, of some particular governmental department, spouting out virtuous indignation at the lack of co-ordination exhibited generally, and predicting disaster for our cause from procrastination and diffusion of energy. And indeed, it seems at times as though the man on the street has ample grounds for complaint. First, he observes certain elected legislators practising law in the Senate, obstructing essential legislation, creating boards—long, narrow and wooden—for positions needing centralized authority in the hands of one energetic administrator; investigating suspiciously and even vilifying the personality of any man or committee who really gets things done without asking for advice, all in a manner highly pleasing to the Imperial German Government. Next he observes interminable squabbles between Denman, lawyer, and Goethals, canal builder, on the proper way to build up a merchant fleet, they meanwhile doggedly forgetting that they are connected with an *Emergency* Fleet Corporation. And as a final straw he observes the spectacle of one cabinet member branding as exorbitant and impossible a coal-price tentatively fixed at a conference between a brother cabinet member and a large number of coal producers, even after a third member of the cabinet had told the conference to be careful not to do anything in restraint of trade, in effect warning them against doing anything and yet saying that something must be done.

This lack of co-ordination is only natural. Happily, the American democracy has not the highly centralized ("efficient," if you will) legislative, administrative and judicial branches of the German "democracy." Nor have we for years been bending every energy, adapting every industry, training every son, co-ordinating every activity, suborning all education toward "der Tag," when we at last would smash our way into our place in the sun. Our Government was built on the practices, ideas, and ideals of peace, and such an intricate structure cannot face about sharply to the pursuit of war without sundry creaking in the joints, clattering of furniture, and general dislocation.

We would therefore counsel patience. Put yourself in his place. Most of the troubles appear to arise from a lack of fixed, definite, and coherent war policy. The change in function of our various governmental departments is no more radical than these: Suppose that a sugar expert should suddenly be transported to the center of a powder factory, or that a cyanide man be

given charge of an electrical steel-furnace, each with the admonition that he take hold, make a record production, and, above all, get busy *quick*. Would there not be an extreme liability for diverse and sundry flashes, a falling off of the power factor, accompanied by more or less short-circuiting and various other fireworks?

Unless the man were absolutely worthless the best he could do would be to call in various disinterested experts, familiar with those details strange to him, and accept and act upon their advice. We may be thankful for the assurance that notwithstanding the suspicions of certain Senators, this is being done to an extent before undreamed of; red tape and tradition is being thrown aside in large volume, and replaced by common sense and progress. The informed engineer even sees reassuring evidence of co-ordination between governmental official and technical advisers in Secretary Baker's recent statement that only $4,000,000 of the $20,000,000 available for a nitrate plant would be expended at this time. The Government is apparently hesitating before it embarks upon the development of a water power nitrate-plant, and in this is wisely following expert opinion given originally by the Committee on Public Relations of the American Electrochemical Society just a year ago. Doubtless, the Department is wisely keeping the precise plans very secret, and it is impossible to form an opinion as to the process or processes it intends to utilize. It is safe to say, however, that if some power-consuming process be adopted, there will be means for securing the necessary electricity instantly from systems at present constructed and operating without the necessity of delaying production until a large dam and hydro-electric station can be installed, a matter taking at least a year of the speediest construction. Here again there seems but little justification for the fulminations of the daily press upon the lack of enterprise in essential preparations.

Finally, one should not forget that a censorship prevents the publication of news about the *accomplishments* of a nation at war; only the obverse and darker side of the picture is held up for public inspection. We therefore recommend a little stabilizing trip for the man who looks about him and sees no evidence of war-activity, when he gets to seeing and purveying only gloom. Let him run over to one of the training camps for the officers' reserve, or to a concentration camp for the new army, or to an aviation school. Even if a watchful sentry prevents him from getting very close to the hive of activity, still he can absorb a different and saner viewpoint by contact around the edges.

Regulating Steel Prices

Everyone knows, first, that there is a controversy between the authorities at Washington and the steel manufacturers over the price the Government should pay for such steel as it needs to prosecute the war, and second, that there is a disposition, or a desire, in Washington to fix maximum limits for the price of steel that may be sold to private consumers. Beyond this nobody seems to know anything. The parties are maneuvering for position and will not commit themselves to anything specific. If the public undertakes to draw inferences as to their real intentions, a hopeless puzzle results. Washington does nothing but wield the big stick it picked up at the beginning of the war: "Cost plus 10 per cent!" while the steel makers allow it to be assumed that they are contending for a price in relation to the present market, whereas in fact there is no regular market in existence.

Neither party is serious. It is simply maneuvering. Let us see what "cost plus 10 per cent" would mean. Using a weighted average of the finished steel products, the lowest selling price in the past 15 years was about 1.42 cents per pound, in December, 1914. There were practically no profits then, but on a full output there would have been some profit. Then, assuming 1.30 cents as the average cost, 10 per cent profit on an output of 31,000,000 gross tons a year would net $90,000,000 for the American steel industry. In the United States Steel Corporation's four poorest years in its 16 years' history it averaged about that amount, with an output barely more than one-fourth as great. The steel industry cannot possibly turn its capital fast enough, having such a large investment per ton of output.

Now if there is a market at present, what is it but the price at which one can buy for delivery not longer than a few months hence? That would be 4½ cents or more for bars and shapes, about ten cents for plates, perhaps nine cents for sheets, and various other prices beyond all market precedent, even the precedent of a few months ago. The weighted average already used would work out not less than six cents per pound of steel. Even if the cost of production has increased 50 per cent, which of course it has not, the profit on a year's output would be two and three-quarter billion dollars, or an amount quite close to the total capitalization of the industry.

The three heavy products in the steel industry are bars, shapes and plates. The average market price in the ten years 1905 to 1914 inclusive was: Bars, 1.385c.; shapes, 1.472c.; plates, 1.456c., an average of 1.44c. Profits must have been fairly satisfactory as dividends were paid and new plants built from earnings. Chairman Denman of the Shipping Board set 2.50c. as the price to be paid for bars, plates and shapes for the merchant ships the Emergency Fleet Corporation is to build. If 1.44c. were the production cost, the profit at 2.50 cents would be such that, if applied to the entire steel output, the total would be about $730,000,000, or more than double the Steel Corporation's earnings last year—those earnings having been more than double the earnings in any previous year. In passing, it might be noted that the Steel Corporation produces approximately one-half the country's steel output.

One reason for the rejection of Chairman Denman's proposed prices was doubtless that if they were agreed upon an effort might have followed to force the prices down farther. Another reason, of course, was that plates, the commodity chiefly needed, were put at the

same level as bars and shapes, whereas market conditions have long established a much higher price for plates than for the other commodities. Doubtless another reason was the danger that if such prices were arranged for Government steel, there might be another step; to fix prices for all buyers at the Government level.

Thus there is no indication that the two parties are defining their position so as to reach a common ground. The measure should be the amount of profit it is fair that steel producers should make in times like these. Should the profits be larger or smaller than those of 1916? In that year they were almost three times the average profits of 1912-13-14, which figure is taken in the Senate law as being the basis for computing "excess profits." If 1916 be taken as a standard from which to make a departure, it might then be determined whether or not extra profits should be allowed sufficient to cover the excess profits tax, leaving the steel producers with the same net earnings as before. To the average prices realized in 1916 there could be added an amount equal to the increase in cost of production, not especially difficult to ascertain. The result would be a schedule of prices applicable both to the Government and to private consumers, in accordance with the "one price to all" doctrine enunciated by President Wilson in his statement made public July 12.

Wanted:—An Industrial Army

The thoughtful observer is depressed by the continual news of strikes, large and small, which appears from all sides. Few of them involve a considerable body of men actually on strike, but in their influence on allied and subsequent manufacturing processes it is quite probable that they are materially affecting the volume of some much-needed output. The refusal of a few dozen electricians or hoisting engineers to continue work in some mining district could very easily paralyze production—not a miner could work, if he would. Immediately smelter receipts will be curtailed, causing partial or complete shutdown, which in turn is reflected in a diminishing refinery output. Only one or two weeks ago a strike among machinists in the shipbuilding yards near New York threatened a complete shutdown of this most essential construction.

It is not a question of the laborer lacking patriotism. The patriotism of the American citizen, be he workman or employer, is beyond suspicion; unfortunately, however, he fails to realize the full consequence of his attitude. We are all heartily in favor of economy, as long as it doesn't interfere with our comfort or our business. All of the manufacturers are pointing with pride to their willingness to co-operate with the Government as to price and production, while Wall Street trembles to a falling market. The press is anxious to raise a large part of the war budget by taxation as long as the postal rates are not increased. The American farmer is glad to produce wheat enough to feed the world at a minimum price of two dollars a bushel. The American unionist will cooperate with the Government in a closed shop.

We have yet only dimly glimpsed what this war is going to mean to each of us; we have not yet a shadow of the profound effect it will have on our public and private life, habits, and character. For compulsion, that ugly thing, has come into our state, hand in hand with his uglier master, war. Martial law is supplanting civil law. A conscript replaces a volunteer. Price-fixing supersedes the law of supply and demand. Commandeering guarantees adequate output.

But how can even a commandeered factory produce munitions without workmen? And who is to certify that machinist Stillson will take orders from Foreman Trott any more willingly to-morrow when Superintendent Brisk receives directions from under-secretary Tape than to-day when Brisk is in touch with managing-director Bond? He is still working in the same old shop, at the same old machine, turning out the same old product, cussed by the same old bosses, getting the same old pay envelope, and listening to the same old agitators.

It seems a pity that the Government is not to utilize the key to the labor situation, which is already in its hands, ready for adaption, in the draft law. Men with families will not be called into military service, principally because it is more economical to leave them behind to take care of their dependents. But simply because such a man is exempt from combatant duty, he should by no means be exempt from *service*. How simple it would be to enlist him into an industrial army—divisions of farmers, blacksmiths, carpenters, miners, trades and occupations of all sorts, organized for *service*, enlisted in our cause, ready to go where they are needed, and to work with their hands and brains in turning out the munitions so essential to the war.

Such a mobile industrial army would have a profound moral as well as material effect at the first hint of labor trouble. Unanimity would be impossible because a certain proportion of the men would already be drafted into the industrial army. They *could* not quit, short of treason. Any other man of divided allegiance would be assured that when he left work, there would quickly appear soldiers of the United States of America, willing and ready to do their bit to help win the war by maintaining production.

Commandeering of both plants and labor is as essential to the conduct of our war as is conscription of the army, and as inevitable. It might appear difficult, if not impossible, to decide such questions as, "What industries are essential?", "What particular portions of these industries should be commandeered?", "What trades within these factories should be fool proof?", "Where and when shall we move our 'soldiers of peace'?". The determination of such matters will sooner or later be placed in the hands of a well-organized Department of Munitions and Production—why not do it sooner?

The organization of this industrial army would be comparatively simple. The mechanism of its selection is already in our hands. Why not use it?

Readers' Views and Comments

Sampling vs. Correct Analytical Results

To the Editor of Metallurgical & Chemical Engineering

Analytical chemists in U. S. A. have lately been much agitated over the discovery that certain widely-advertised chemicals used for laboratory purposes are not so pure as their labels indicate, and a discussion upon the value of "analyzed chemicals" has taken place in the press, and also before some sections of the American Chemical Society. This discussion proves once again that the sampling of any commercial product is quite as important as the analysis of the sample when obtained, and that more supervision ought to be given to the preliminary work of selecting and preparing the sample.

As a chemist of considerable experience in manufacturing work and with a knowledge of the conditions that usually obtain when samples of bulk-deliveries are taken for analysis, the writer can state that in nine cases out of ten, this work is entrusted to youths or men with insufficient training and knowledge for the work. Very many of the disputes that arise between the sellers and buyers regarding the purity or strength of the commodities sold, are due in fact not so much to the inaccuracy of the analytical methods, as to inaccurate sampling.

The widely prevalent idea that any man or youth provided with the necessary tackle can be trusted to produce a fair and accurate sample of a manufactured chemical product without any supervision, must be eradicated before progress toward greater accuracy can be attained.

There are instances no doubt, in which the chemist himself cannot spare the time necessary for constant supervision of this work, as in the case of large purchases of ores, shipped by sea or rail in bulk. When this is the case, the oversight of the sampling must naturally be delegated to some competent and intelligent man, who has been well-trained in the theory and practice of sampling, by the chemist whose place he is to take. Since attempts to bribe samplers are by no means uncommon, a man of strong character and stiff moral backbone should be selected for the job.

As regards the common faults of sampling, there are three conditions which must be observed, if a fair sample of any commodity is to be obtained:

(1) The original sample taken must be large enough to represent all portions of the bulk, and a fair proportion between large and smalls must be maintained.

(2) The sample must be reduced by repeated crushings, mixings, and quarterings, to the small quantity required for the actual test.

(3) In order to continue the crushings and quarterings up to the required degree of fineness, it is necessary to dry the sample at some intermediate stage. A wet or damp sample cannot be ground to pass through a 60-mesh brass wire sieve used for the final stage of sampling.

Conditions (1) and (3) are those which are most often neglected in practice by those entrusted with the sampling operation. The first calls for the exercise of careful judgment and considerable intelligence on the part of the sampler, while the third demands great patience, especially with ores and other hard materials. The crushing and passing through the sieve of the last portion of the sample is the most important part of the sampler's work, since in many cases the impurity is harder than the pure substance, and to throw these last fractions of the original sample away, because they are difficult to grind, is a fatal error.

In conclusion, it may be stated that the need for some greater degree of uniformity in sampling methods is urgent. Chemists as a class have recognized the necessity for standardization of their methods of analysis, but the equally important work of sampling has been left too long in the hands of the ignorant, and until this is remedied by the chemist himself taking control, we shall have disputes between buyers and sellers concerning the purity and strength of *"analyzed"* and other chemical products.

John B. C. Kershaw.

9 Grosvenor Road, Colwyn Bay, Liverpool, England.

Price Fixing by the Idealist

To the Editor of Metallurgical & Chemical Engineering

Sir:—Among the most interesting features of the present commercial conditions growing out of the war is the question as to what constitutes a fair price, and how much profit shall be made on commodities required by the government. The problem is a perplexing one, and can never be solved to the entire satisfaction of all concerned, involving as it does so many phases of supply and demand, as well as the human frailities of greed and avarice—so that it is almost impossible to arrive at any cost figure upon which to base a fair margin of profit. This generation is witnessing a remarkable change in many things, and in the viewpoints from which things are looked at, and eventually the problem of gain will be solved just as drunkenness and autocracy are being solved by the people arriving at a decision as to what constitutes success or failure from a mundane point of view.

After all has been said and done—every man, woman, and child on earth values the good opinion of their fellows higher than anything else upon earth, and just as fast as we learn that ostentation and display are no longer sufficiently interesting to draw the homage we desire, just that fast will we solve the questions now so vexatious and trying to all of us. This war has taught us many things, and will teach us many more, and if the net result increases the happiness and contentment of man upon earth, the result will be worth all it costs. If our manufacturers and producers and middlemen can come out of this trying period chastened, and with a clean spirit, with the lesson of live and let live fully learned and digested, then we will see changes in our business morale, now regarded as chimerical.

The state must be greater than the individual, but the state can only maintain its greatness if its individual units are sound and true. So in this price-fixing we must have a frankness and honesty between

the state and the individual producer which has never been conceived of heretofore. Men are learning rapidly that beyond a certain line great wealth means more or less discontent, and that service to their fellowman is after all the most satisfying thing upon earth, whether requited or not; and now the opportunity has come to us of the U. S. A. to show that our ideals go further than being merely the richest people upon the earth. Let our great captains of industry throw open their books to the government agents; let them say we pay so much to produce this article; we need so much to maintain our plants and properly take care of ourselves and our stockholders—beyond that point our profits are the property of the U. S. A., to be used to bring about that coalition of nations, which shall from now on make the whole world a better place to live in—not for the 10 per cent on top, but for the submerged 90 per cent, who for countless generations have borne the brunt and travail of life, but whom we now see have just as much right to human happiness and security as ourselves, and let our particular line of big business see that we do our part to give it to them.

H. B. COHO.

New York City.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

CORRECTION

In the article by T. Kurahashi on "Recent Developments in the By-Product Coking Industry of Japan," Vol. XVI, June 15, 1917, page 700, the eighth paragraph should read:

"The Imperial Steel Works, the most distinguished steel and iron works in the Orient, have coke plants for the blast furnaces. They were formerly beehive ovens of the Coppee type, but are now by-product ovens of the Semet-Solvay and Koppers types."

Memoranda on Submarines

The Engineering Committee of the National Research Council issues the following data to guide those desirous of helping to circumvent the Enemy's submarine campaign by means of invention and suggestion. Any communication on the subject should be addressed to W. F. Durand, vice-chairman of the committee, at Washington.

Submarines operate singly or in groups as may seem best suited to local or special conditions.

They are supposed, where circumstances favor, to lie on the bottom at rest and with listening devices attempt to detect the approach of vessels. On receipt of evidence that a vessel is approaching, they rise to a level permitting observation with periscope, and then maneuver accordingly. When in water too deep to permit lying on bottom, the submarine must maintain steerage way in order to hold its level of submergence. The minimum speed at which this can be done will range with circumstances from 2 to 4 knots. The maximum depth of submergence is about 200 ft. The usual depth of running is from 50 to 100 ft.

They have been supposed to return to the home base at intervals of 30 to 35 days. The total radius of action will presumably range from 5000 to 8000 miles at a moderate cruising speed of 10 or 11 knots. The high speed emerged will range from 14 to 18 knots, or possibly more in latest designs. The maximum submerged speed is about 10 knots.

Hidden bases have been presumably used off the Irish and other coasts. There have aso been suspicions of bases on the coasts of Greenland and Iceland. Submerged bases for oil and supplies are used.

The time required from emergence to submergence will range from 1 to 3 or 4 minutes, according to circumstances. When submerged near the surface, the time required to raise the periscope, take a quick observation and lower it again, may range from 15 to 30 seconds. If desired, the submarine can follow an undulating path, rising and submerging alternately, at frequent intervals, at will. Or otherwise it may run fully submerged but near the surface and take frequent observation through the periscope. Modern submarines are provided with two or three periscopes. The loss or destruction of one, therefore, will not necessarily disable the boat.

Torpedoes fired from submarines are presumably aimed by changing the direction of the boat. This, however, is not assured in all cases. The torpedo, in order to run true, must travel at an immersion of about 10 ft. In smooth water it may be run at a shallower depth than in rough water.

Submarines may operate at night with less liability of detection, but with, of course, greater difficulty in picking up their target.

Submarines use the gyroscopic compass.

Sounds produced by the movement of a submarine through the water, including those traceable to the propeller, to movements of the rudder, etc., should permit of detection by the use of modern refined sound-detecting devices.

The distance at which a protecting net, plate, or shield or other means of exploding the torpedo before reaching the side of the ship must be located in order that such distance will render the effect of the torpedo harmless, will depend primarily upon (1) Weight of explosive charge, (2) Depth of torpedo when exploded, (3) Strength of the ship's structure. With modern torpedoes and a depth of 10 or 12 ft., and with the structure of modern merchant ships, distances of 20 or 30 ft. would perhaps be required in order to give good assurance against injury. With rough water and possibly much less submergence at the time of explosion, reduced distances of 15 or 20 ft. might prove sufficient. Experimental investigations on this subject show a very wide divergence among the results and no precise rule can be given. It may be added, however, that naval constructors generally are satisfied that the distance at which protecting plates or shields would have to be placed in order to secure immunity is so great as to render their use of very doubtful practicability.

Third National Exposition of Chemical Industries

Everything points to the Third National Exposition of Chemical Industries to be held at the Grand Central Palace, New York, during the week of Sept. 24th, being a much greater success than its predecessors. It will be the largest and most complete exposition of these industries ever held at any place in the world.

At the last exposition two floors of the big building were occupied by 187 exhibitors. This year three floors, possibly more, will be occupied. Already the list of exhibitors contains 250 names of companies entering every field of industry.

On Monday, Sept. 24, at 2 P. M., opening addresses will be made by Dr. Charles H. Herty, chairman of the Advisory Committee of the Exposition and editor of the Journal of Industrial and Engineering Chemistry, by Prof. Julius Stieglitz, president of the American Chemical Society, and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers.

Among other speakers on the program for other days are Mr. W. S. Kies, vice-president National City Bank, who will speak upon "The Development of Export Trade with South America"; Prof. Marston Taylor Bogert, chairman Chemistry Committee, National Research Council, who will speak upon "The Operation and Work of the National Research Council for the National Weal." Dr. L. H. Baekeland of the Naval Consulting Board will make an address on "The Future of American Chemical Industry."

One day will be devoted to a symposium upon the national Resources as Opportunities for Chemical Industries, and among the speakers will be: Mr. C. H. Crawford, assistant to president of Nashville, Chattanooga & St. Louis Ry.; Mr. V. V. Kelsey, chemist-industrial agent, Carolina, Clinchfield & Ohio Ry.; Dr. E. A. Schubert, mineralogist-geologist, Norfolk & Western Railway; Dr. T. P. Maynard, mineralogist-geologist, Central of Georgia Ry. and Atlantic Coast Line Ry.; Dr. J. H. Watkins, geologist, Southern Railway.

The motion-picture program will be one of wide interest. The American Cyanamid Company and General Electric Company have already arranged to supply their films. The Bureau of Commercial Economics at Washington will supply many toward completing the range of industrial films.

Fall Meeting of American Electrochemical Society

The thirty-second general meeting of the American Electrochemical Society will be held in Pittsburgh Oct. 3 to 6. A special feature of the meeting will be a series of papers and discussions on Electrochemical War Supplies, and the part the electrochemical industry will play in the present struggle.

The committee in charge is outlining an elaborate program of technical sessions, visits to industrial plants and entertainment features. It invites the delegates to arrive in Pittsburgh on Wednesday, Oct. 2, so as to get together informally and enjoy some recreations which have been planned for them.

On Thursday, Oct. 3, a regular meeting of the society will be held in the morning, with optional excursions to industrial plants in the afternoon. In the evening an illustrated lecture on a semi-technical subject will be given.

On Friday, Oct. 4, a symposium on Electrochemical War Supplies will be held in the morning, followed by excursions to industrial plants in the afternoon. A subscription dinner will be held at the William Penn Hotel in the evening, with special entertainment features. The ladies are especially invited to be present at this function.

Saturday, Oct. 5, will be devoted to an all-day excursion, on a special train with complimentary luncheon, to several industrial plants in the Pittsburgh district.

An Opportunity for Metallurgists

Many technically trained men, beyond conscription age or otherwise, have wondered how they might now be doing their part to aid in winning our war. They have felt that a personal offer of service would only add another straw upon the shoulders of already overworked officials and bring no results, since the government could scarcely know the individual and material equipment of the man or concern making the offer. A plan is well under way at present, however, which will allow the individual engineer to use as much of his time and energy as is available in attacking problems directly connected with the war.

In the furtherance of this scheme, the national engineering societies will receive from various governmental departments a list of the unsolved engineering problems confronting them. Such of these problems as would probably fall within the scope of their individual membership will be listed and sent to each member, with the earnest request that the recipient devote as much of his time as possible to the solution of that problem nearest fitted to his knowledge, staff or plant. In this way will each engineer of this country, and there are dozens of thousands of them, be able to apply his own personal resources to the full extent of his time and inclination, knowing that his efforts will be directly contributing toward the successful prosecution of the war.

Through properly constituted committees he will also be kept constantly in touch with other engineers working on various phases of the same problem, and when success crowns their efforts, the results will be forwarded to the proper governmental department through the National Research Council.

At a meeting of the New York Section of the American Institute of Mining Engineers, held at the Machinery Club on July 20, a very clear call was sounded which should be heeded by metallurgists throughout the country. Mr. Donnell F. Hewett of the United States Geological Survey called attention to the fact that in order to produce 50,000,000 tons of steel, requiring 17 lb. of 80 per cent ferromanganese per ton, would call for the consumption of not less than 400,000 tons of this alloy, necessitating the mining, transportation and smelting of over a million tons of manganese ore; the exact amount depending, of course, upon the tenor.

Mr. Hewett further pointed out that the production of the United States could not possibly be expected to fulfill our minimum requirements, inasmuch as the whole body of developed ore is only equal to some three years' consumption. The mining of manganese has indeed been growing by leaps and bounds, even to the

extent of doubling its output annually, but unlimited expansion and intensive production are not likely owing to the nature of the known deposits—they are local enrichments in the upper few hundred feet of the earth's crust, quite local and variable in extent, geological environment, and mining methods. The best expectancy is for a small production of high-grade ore containing more than 40 per cent manganese suitable for making ferromanganese; a larger production of medium-grade ore containing 15 to 40 per cent manganese, and also a large production of low-grade ore, containing less than 15 per cent manganese, the latter two classes suitable for making spiegel. The present deficit between production and consumption is now being met by imports, largely from Brazil. The Brazilian deposits could easily tide us over the interim were we assured of adequate water transportation, which unfortunately is growing scarcer and dearer, and may even be absolutely terminated, the ships being diverted into more necessary military service.

Here is the metallurgist's opportunity. The winning of the war means the production of steel, more steel, millions of tons of steel, and each pound of steel requires a certain fraction of a pound of manganese as a deoxidizer. If, as is easily possible, this manganese may not be had at any price, the possession of unlimited iron ore, blast furnaces, steel mills and munition factories will avail us nothing, unless the metallurgist can point out some way of using our limited supply of this important element to better advantage, or develop some acceptable substitute, as was clearly pointed out in the general discussion following the formal addresses.

Good steel can be made in the crucible process without manganese. Other processes operate with heavily oxidizing conditions in the furnace laboratory, and the result is a steel containing much oxygen in solution, or as oxides, alloyed, or mechanically mixed. If poured in that condition the resulting ingot would be "red-short" and useless, cracking and breaking badly under rolling, forging or other mechanical work. The early English-made Bessemer steel had this defect, and only after much experimental work which drained his resources did the inventor discover that manganese remedied the defect. It appears, however, that the *presence* of manganese is not so important as the *absence* of oxygen and oxides. Manganese stands pre-eminent as an oxygen eliminator, not only reducing any iron oxide which it may encounter in the steel, but forming a liquid slag which washes out other mechanically entrapped oxides and separates freely from the hot metal. A certain excess not only insures good, tough steel, but also neutralizes largely the harmful effect of that omnipresent and tenacious element, sulphur.

In these two respects manganese is matchless. Silicon and aluminium metal are powerful deoxidizers, but must be added in somewhat larger quantity than manganese; further, the oxides which are formed are very infusible and tend to remain in the metal itself, forming "sonims," solid non-metallic impurities very detrimental to the tenacity, toughness and general usefulness of the resulting metal. However, it is possible to substitute silicon for perhaps 25 per cent of the manganese, the resulting manganese silicates being readily eliminated from the liquid metal.

An acceptable substitute must therefore have these properties: First, it should remove oxygen from iron compounds or solutions; second, the resulting oxides should be easily and thoroughly eliminated from the steel; third, the presence of an excess should not be detrimental to the metal.

Owing to the exacting scrutiny and slow adoption which such a substitute would undergo, a more profitable line of attack would appear to be in the direction of a better utilization of our present supplies of manganese. Two possibilities are here open: first, to get more of the manganese from the available ores into usable condition, and second, to use that manganese metal more efficiently.

Manganese ores may be regarded as mixtures of oxidized iron and manganese compounds, with more or less gangue material, often siliceous. If the ore is high in iron and low in manganese it is usually smelted in an ordinary iron blast furnace, operating very hot. The result is an iron-manganese alloy called spiegel, containing perhaps 5 per cent of carbon and 20 per cent manganese. Concentration of manganese in the blast furnace appears to be impossible, if one considers the silica which is always present. If the furnace is run too hot as much as 20 per cent of the manganese may volatilize and be lost; on the other hand, in a cooler furnace the manganese replaces the iron in the silicate slag and is wasted.

Higher manganese alloys—"ferromanganese"—are prepared in the electric furnace, which makes a standard product containing 80 per cent manganese and low in carbon. The use of this alloy is seen to be indispensable in the production of low-carbon alloys; 17 lb. of manganese as spiegel would simultaneously add 20 points (0.20 per cent) of carbon to the metal. Spiegel is rather easily made, although very wasteful of manganese. Further than that, its use is limited to higher carbon steels. Still, the bulk of American ores are so low in grade as to produce nothing else, and at the same time may be rather high in silica and phosphorus. It would seem of prime importance to develop methods in which lower grade ores might be smelted to merchantable spiegel by concentrating the manganese before smelting, and by protecting it during smelting. The next step would be to develop methods of producing ferromanganese from spiegel, for which there are a number of interesting possibilties. Or, finally, the problem of producing manganese metal by direct electrolysis of ore in solution in a bath of molten metallic salts appears to await successful solution, and the various practical limitations and operating details determined. In this matter it appears highly important for the steel producer to cease demanding either 20 per cent or 80 per cent alloys and accept intermediate analyses.

A final, most interesting possibility would obviate the addition of certain quantities of manganese by the utilization of that manganese present in ordinary pig iron, or in the steel scrap melted in the open-hearth furnace.

It is well known that carbon, while having a rather low "affinity" for oxygen at ordinary temperatures, becomes more and more voracious in its appetite for oxygen, reducing even the most refractory oxides at higher and higher temperatures. Take the case of phosphorus and carbon—at room temperatures and even up to the temperature of the puddling furnace, phosphorus has a greater affinity for oxygen than carbon, and consequently is eliminated from the bath

before any considerable quantity of the carbon. The somewhat higher temperature of the open-hearth furnace represents a region where the relative affinity of the two elements is about equal, and the phosphorous and carbon are eliminated from the bath almost simultaneously. At the yet more intense temperature prevailing in the Bessemer converter, however, the affinity of carbon has become greater than of phosphorus, and the former must be completely eliminated before any loss in the phosphorous occurs—exactly the opposite state of affairs from that which occurs in the manufacture of wrought iron.

The same thing is true of manganese. In all normal furnace operations the elimination of manganese is complete before the last of the carbon—in other words, at those temperatures manganese has a greater affinity for oxygen than carbon. But from the first, Bessemer steel has been made from pig containing so much manganese, and at so high a temperature that at the end of the carbon blow there is still enough "residual manganese" to effectually kill the melt. A modern metallurgist does not wonder that when Sir Henry Bessemer's process was first applied to English pig, low in manganese, the result was impossible. Again, the first manufacturers of basic steel were rather puzzled to find that toward the end of the heat, after all manganese had once been eliminated from the bath, test bars suddenly showed *unmistakable presence of considerable manganese.*

The explanation seems simple. The temperature has risen to such a point that the affinity for oxygen of the remaining carbon in the melt reaches and passes that of manganese, with the result that manganese is reduced from the slag and re-enters the metal.

Why is it not possible to effectually "kill" a metallic bath (if elimination of the oxygen is the prime desideratum) by a proper determination and application of the physico-chemical laws governing the relative affinity of manganese, carbon and other elements for oxygen in such a manner that a large part of this most important work may be done at a proper temperature under a slag no higher in manganese than the low-grade ores of this country and utilizing the same manganese previously eliminated from the bath with the other "impurities"?

September Meeting of American Chemical Society

War Problems to Be Discussed at Boston

The September meeting of the American Chemical Society will be held in the buildings of the Massachusetts Institute of Technology, Charles River Road, Cambridge, Mass., Sept. 11, 12 and 13, 1917. The Northeastern Section has been requested by the directors to omit the usual annual banquet and excursions, and to arrange a program characterized by simplicity and seriousness, and bearing as fully as possible on questions concerning the activities of chemists—both in the government service and in the industries during the war.

The following is a list of the chairmen of local committees:

Executive—H. P. Talbot, Massachusetts Institute of Technology, Cambridge, Mass.

Finance—A. D. Little, 93 Broad Street, Boston, Mass.

Registration—K. L. Mark, Simmons College, Brookline, Mass.

Entertainment—R. S. Williams, Mass. Inst. of Tech., Cambridge, Mass.

Press and Publicity—R. W. Neff, 22 India Square, Boston, Mass.

Entertainment of Ladies—Mrs. A. D. Little.

Registration will be conducted at the buildings of the Massachusetts Institute of Technology, Cambridge, except on Monday, Sept. 10, when it will be held at the Hotel Lenox.

Society headquarters will be at the Hotel Lenox at the corner of Boylston and Exeter Streets.

The use of the Engineers' Club, at the corner of Arlington Street and Commonwealth Avenue, will be extended to all members of the Society.

GENERAL PROGRAM

Monday, September 10

4.00 p. m.—Council Meeting. Engineers' Club.

7.00 p. m.—Dinner to the Council at the Engineers' Club (tendered by the Northeastern Section).

Tuesday, September 11

10.00 a. m.—General Meeting of the Society in the Massachusetts Institute of Technology.

Address of Welcome:

Dr. R. C. Maclaurin, President Massachusetts Institute of Technology.

Response:

Julius Stieglitz, President Americal Chemical Society.

General Papers.

2.00 p. m.—General Conference on Chemistry and Chemistry in Warfare, opened by William H. Nichols, Chairman Committee on Chemicals, Council of National Defense. Marston T. Bogert, Chairman Chemistry Committee, National Research Council.

5.00 p. m.—Harbor trip to Hotel Pemberton, where an informal shore dinner and smoker will be held.

Wednesday, September 12

Morning.—Conferences of Divisions.

Afternoon.—Divisional Meetings.

Evening.—President's Address, Huntington Hall, Rogers Building, Massachusetts Institute of Technology, Boylston Street.

Thursday, September 13

Morning and Afternoon.—Divisional Meetings.

The Metallurgy of Lead Ores in the Lower Mississippi Valley[1]

By Herman Garlichs, E. M.

The first metallurgists in Missouri were the Indian and the hunter. The early settler learned to procure his bullets either by melting ore in his camp fire or by throwing pieces of galena on an old stump and depending on the usual roasting and reaction method to obtain the metal.

Various other older practices may be passed over lightly, as many of them are now practically abandoned. The earliest smelting furnace was the log hearth, which was followed by the "ash" furnace, the English reverberatory, the Backwoods and water-backed hearth.

[1]An abstract of a paper to be presented at the St. Louis Meeting of the American Institute of Mining Engineers, October, 1917.

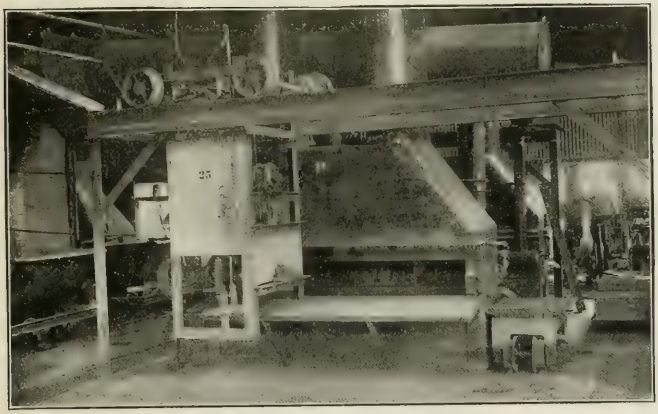

FIG. 1—RABBLING MACHINE AT BEGINNING OF TRIP

Much information regarding these processes may be obtained from *Missouri Geological Survey*, Volume VI; *Illinois Geological Survey, Bulletin* 21; and Pulsifer: *Notes for a History of Lead.*

The reverberatory and hearth methods require pure ores. On this class of ores these processes give fair results when care is taken in smelting. The yield ranges from 80 to 90 per cent of the lead in the ores, allowing no recovery in fume. The blast furnace preceded by roasting in reverberatory is adapted to ores that are less rich in lead, and contain impurities which would cause severe losses if treated by any other process. Also, when there is a large amount of ore to be treated, with scarcity of labor, the blast-furnace process is the more economical.

ANALYSES OF ORES AS MINED IN SOUTHEAST MISSOURI, AND OF VARIOUS GRADES OF RESULTING CONCENTRATES

	Ag. %	Cu. %	Pb. %	SiO_2, %	Fe, %	Al_2O_3, %	CaO, %	MgO, %	Zn, %	S, %	Ni and Co, %
Ore	0.12	0.06	5.7	5.0	4.1	4.9	25.5	14.2	0.8	2.0	...
High-grade concentrates	0.7	0.13	73.2	1.0	3.5	..	2.6	0.8	0.4	15.0	0.05
Medium concentrates	1.3	0.12	68.6	1.4	4.6	..	3.1	1.4	0.8	15.5	0.06
Low-grade concentrates	1.0	0.30	65.8	0.5	3.1	0.5	4.3	2.8	1.7	13.7	...
Flotation slimes	...	0.50	45.0	9.6	4.4	3.1	7.5	4.2	4.0	12.3	...
Flotation slimes High-grade	3.7	0.05	57.8	6.0	2.7	..	2.2	1.4	9.4	15.5	...
Joplin concentrates	...	...	80.2	1.1	1.0	..	0.4	..	1.7	13.3	...

Analyses of the ores as mined in southeast Missouri—which are about the average of the district—also analyses of various grades of resulting concentrates, show that the metallurgy is simple, the removal of the sulphur and the slagging of the dolomite in the blast furnace being of prime importance.

The big improvements which have revolutionized the metallurgy of the Mississippi Valley ores in the last 10 or 12 years are:

1. The introduction of Hunting-ton-Heberlein pot roasting, preceded by a preliminary roast in a mechanical furnace (Godfrey), subsequently smelting in the blast furnace and filtering all fumes through cotton or woolen bags.

2. The introduction of the Dwight-Lloyd sintering process, which eliminated preliminary roasting of the concentrates (but not of the mattes), with subsequent smelting in blast furnace with bag-houses attached.

At Herculaneum, the Godfrey pre-roasting furnaces were abandoned in the Huntington-Heberlein process, and the Wedge roaster was adopted for the pre-roasting of mattes. Later it became apparent that the elimination of sulphur was still unsatisfactory, and that there was an undesirable but necessary dilution of the concentrates from 70 to 65 per cent lead to 40 and 45 per cent to render the Dwight-Lloyd machine applicable with a single roast.

To avoid these objections, the double roast is being installed by both the Herculaneum plant of the St. Joseph Lead Co. in Missouri, and the Federal plant of the Federal Lead Co. in Illinois. A rapid preliminary roast is given on a separate line of Dwight-Lloyd machines, and this pre-roasted material is then turned over to another set of Dwight-Lloyd machines (Herculaneum), or to Huntington-Heberlein pots (Federal) to reduce the sulphur of the finished product to about 2 to 2½ per cent, and with its lead contents increased to 50 or 55 per cent.

It is expected that the double roast will effect the following improvements over present methods:

1. To avoid the large production of mattes which lock up lead and require expensive re-treatment for its recovery.

2. To avoid diluting a 65 to 70 per cent lead concentrate to 40 to 45 per cent, which means large additions of barren fluxes.

3. To utilize to the fullest extent the fluxing values in the ores. This means that no limestone should be added

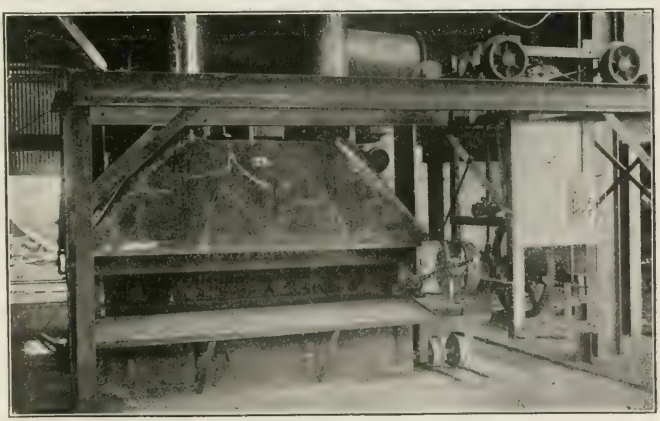

FIG. 2—RABBLING MACHINE AT END OF TRIP

to a blast-furnace charge, while some silica and iron will be required. The resulting blast-furnace slags will contain from 6 to 7 per cent MgO, with a corresponding increase in blast-furnace capacity for original concentrates.

4. To recover a part of the copper in the concentrates, which metal is at present mostly oxidized and lost in the large amount of slags made.

The other important improvement in the metallurgy of Mississippi Valley lead ores was the mechanically rabbled hearth, known as the "St. Louis hearth." This machine was developed at the Collinsville plant of the St. Louis Smelting & Refining Co., and has been fully described by W. E. Newnam.[2]

The St. Louis hearth, which is illustrated in Figs. 1 and 2, is applicable only to concentrates assaying 68 per cent or more in lead, and therein differs from the Huntington-Heberlein and Dwight-Lloyd methods, which treat concentrates of varying grades.

When concentrates assay over 70 per cent it is considered that the hearth shows better recovery in lead, and is the most economical method, although the double roast, when perfected, promises to be equally as cheap as to cost, with the advantage of being able to treat all grades of concentrates.

The peculiar advantages of the mechanical hearth for the higher grade concentrates are:

1. It treats the concentrates undiluted with any flux.

2. It is a very efficient desulphurizer, expelling 95 per cent of the sulphur.

3. It retreats all the dust and fume produced, leaving the gray slag as the only product to be sent to the blast furnace, with a large reduction in slag and matte produced.

4. The hearth makes a total extraction of 82 to 84 per cent of the lead contained in 70 per cent concentrates. With concentrates assaying 75 to 80 per cent in lead, 90 to 95 per cent represents the total extraction, leaving from 5 to 10 per cent of lead contents in the gray slag. This practically eliminates any retreatment of mattes.

The mechanical rabbling machine is limited to 68 per cent lead concentrates, and for this reason, where lower grades of concentrates are received at Collinsville, the Dwight-Lloyd machine must be used as an auxiliary. All mattes produced by smelting the gray slag of the hearths and the Dwight-Lloyd sinter at Collinsville can be easily handled *raw* on the Dwight-Lloyd, so that a Wedge roaster is not needed for pre-roasting.

The St. Joseph Lead Co. is erecting at Herculaneum 12 St. Louis hearths to be used in connection with the double-roast process for the treatment of any excess of high-grade concentrates.

In the southeast district, about 75 per cent of the output of the mills is a high-grade product, applicable to hearth work, the remainder being lower-grade concentrates and flotation slimes. In order to sweeten the mixture for the double roast (*i.e.* to raise its grade) it is necessary to use a certain proportion of the high-grade concentrates for this purpose. The balance of the concentrates should be worked by the mechanical hearth to obtain the most economical results both as to cost and recovery.

[2]See Transactions, American Institute of Mining Engineers, 1916, Vol. 54, p. 485, or Metallurgical and Chemical Engineering, Vol. XIII, Dec. 15, 1915, page 974.

The lead produced from Missouri ores contains very few impurities, and when subjected to a single liquation process can be used for all purposes except corroding. A typical analysis of Missouri undesilverized lead is as follows:

Ag, 0.0080 (2.4 oz. per ton); As, trace; Sb, 0.0030; Bi, trace; Cu, 0.0800; Fe, 0.0015; Zn, trace; Ni and Co, 0.0080; lead by difference, 99.8995.

The Herculaneum and Collinsville plants desilverize part of their lead, recovering about 1 to 2 oz. of silver per ton, and producing an unusually pure lead for the manufacture of white lead and other purposes requiring a very pure lead.

The following analysis of southeast Missouri "refined" indicates the unusual character of Missouri desilverized lead:

Ag, 0.005; As, trace; Sb, 0.0020; Bi, trace; Cu, 0.0002; Fe, 0.0004; Zinc, 0.0004; Lead by difference, 99.9965.

The difference between southeastern Missouri and western refined lead is almost entirely due to bismuth (about 0.05 in Western refined) from which the Missouri ores are singularly free.

The refining of the Missouri crude lead for corroding purposes follows the usual practice, except that no softening furnaces are necessary.

At Collinsville the lead from the blast furnace is poured molten into the drossing kettle. After carefully drossing to eliminate as much copper as possible, it is pumped into a desilverizing kettle. The hearth lead is charged as pig directly into the desilverizing kettle, drossed, and desilverized. Zinc is added, stirred in, and the zinc-silver-lead alloy (crust) is removed. This first crust is reworked in succeeding kettle charges until sufficiently high in silver to be set aside. The resulting retort bullion (lead riches) assays from 500 to 600 oz. Ag per ton, and represents a concentration of the silver contents of 250 to 300 tons of lead into 1 ton of retort bullion. The zinc consumption per ton of refined lead produced is about the same in amount as is consumed in refining argentiferous bullion. Special attention must be given to removing as much copper as possible from the lead to be desilverized.

The quantity of zinc-silver-lead alloy made is insufficient in quantity to warrant the operations of retort and cupels, and heretofore the alloy has been sent to some outside refinery to be separately distilled in retorts, and returns are based on the sampling of the various products obtained, such as retort bullion, dross, spelter, and blue powder. The assay results check quite closely. Retorts and cupels are being installed at Collinsville so as to be able to treat the alloy whenever occasion demands.

St. Louis, Mo.

The Composition of Shell Steel

By Reginald Trautschold, M.E.

The steel used for the manufacture of shells must possess certain physical properties, and with the object in view of assuring such properties the various governments have adopted specifications covering the allowable chemical composition of the stock used. Certain variations must, perforce, be permissible—the chemical "tolerance." The steels universally used may be classified as carbon steels, to which certain other chemical elements are added for improving the quality of the steel and in which there must necessarily be a trace

of other elements which may not be exactly desirable, but cannot be avoided in commercial production.

The object of the chemical specifications is to secure a metal possessing the requisite physical properties, for the strains to which a shell is subjected are all physical, and the efficiency of the shell—its destructive capabilities—is governed not by chemical but by physical properties. Particularly are the physical properties of the steels important in high-explosive shells which are shattered by the charge confined within the projectile. In the case of shrapnel, the properties of the steel are not so important, the main requisite for them being a sufficient tenacity for the projectile to remain intact until moment of "breaking," i. e., the moment of ejection of the shrapnel balls.

The English specifications for high-explosive shell steels are probably the most exacting of any, but those imposed by the United States are sufficiently exacting to prohibit the use of much otherwise available and excellent steel stock. Apart from the iron content, the percentages of chemical elements which may occur in high-explosive shell steel are given in Table 1. With the exception of manganeese, only the maximum allowable percentages are given, so there would seem to be quite a permissible variation in composition. Nevertheless, the allowable percentage of certain elements is so small that exacting mixtures of metal are essential, whether the open-hearth or the converter process is employed in the production of the steel. The specifications of other governments differ somewhat, but the variations cited may be taken as typical of what is generally considered good and necessary practice.

Compared with such requirements, then, the chemical properties of the steel used by the Germans are of particular interest. For, as it must be admitted that the "art" of war has been developed to a high point by this nation, it is altogether probable that the manufacture of shells has been given most careful attention and developed to a high degree of perfection.

TABLE 1

United States Specifications

	Minimum Per Cent	Maximum Per Cent		Minimum Per Cent	Maximum Per Cent
Carbon		0.55	Phosphorus		0.04
Manganese	0.40	1.00	Copper		0.10
Silicon		0.30	Nickel		0.50
Sulphur		0.04			

During the first year of this great war, a number of fragments of the German high-explosive shells which caused such damage in Belgium and France were collected and carefully analyzed in England. These shell pieces were not selected samples, but fragments picked up on battlefields and were presumably parts of projec-

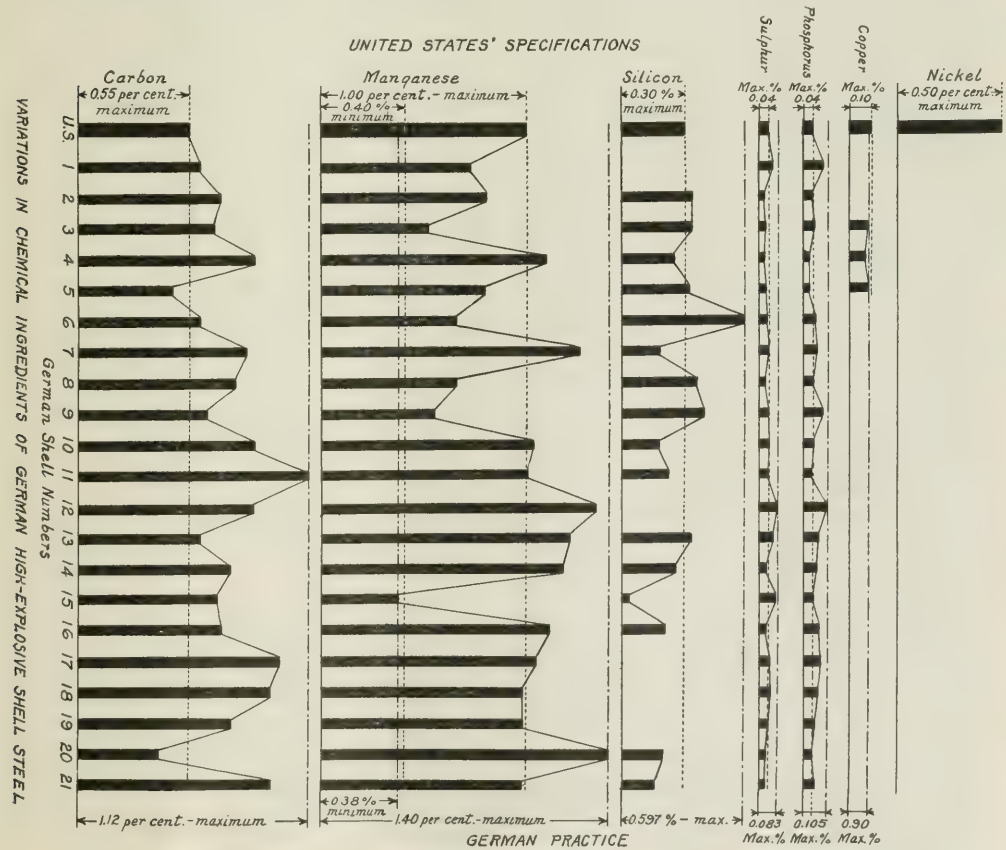

FIG. 1—GRAPHICAL COMPARISON OF UNITED STATES AND GERMAN HIGH-EXPLOSIVE SHELL STEELS

tiles made before the outbreak of the war—projectiles upon the deadly success of which hope of the subjection of Europe, if not of the world, had been based. That is, the fragments collected were unquestionably pieces of the most perfect and most destructive shells the Germans had been able to manufacture at a time when they were in position to obtain any quality of steel they might deem desirable for shell production. This is an important point, for fragments of shells picked up more recently might be of composition which the Teutons had been compelled to adopt by reason of inability to secure metal of better grade. The analysis of the collected samples, which was published by Dr. J. E. Stead in "The Engineer," probably, therefore, depicts the best German practice.

The proportion of the various elements, exclusive of the iron, found in twenty-one of these high-explosive shell-fragments is plotted in Fig. 1. Comparing the chemical composition of these German shells with corresponding allowable percentages in the United States specifications, it will be noted that *not one* German shell would have passed our requirements. Yet every one of these shells was a highly efficient destructive missile.

In the case of carbon content, which, according to our specifications, is limited to 0.55 per cent, there were only two of these tested shells which did not exceed this maximum: in one case the excess was over 100 per cent, while the average excess was 28 per cent.

The manganese content, upon which both a maximum and minimum allowable percentage is fixed in our specifications, does not vary so greatly between German and American practice. Only one of the German shells showed less manganese than our minimum allowance of 0.40 per cent, and this difference was so very slight as to indicate that opinion is pretty well agreed as to the minimum amount of manganese which high-explosive shell steel should contain. About half the German shells equaled or exceeded our allowable maximum of 1 per cent manganese, indicating that our enemies consider the addition of manganese a greater advantage than do our steel experts.

In the case of silicon, when this element is present in German shells, the amount does not differ greatly from our practice, although in one case the German shell contained nearly 100 per cent more than allowable United States maximum. In one quarter of the analyzed shell fragments, however, little or no silicon was found, so it is evidence that this element is not considered so essential in the manufacture of high-explosive shell steel that it need be added to the basic Bessemer steel which doubtless furnished the stock, while, at the same time, an excess of such element seems not to be considered detrimental.

The presence of sulphur and phosphorus is the cause of eliminating much of our steel for high-explosive shell production, but such seems not to be the case in Teutonic manufacture. Although the Germans seem to strive for low percentages of these ingredients they do not reject steel running even some 100 per cent to 150 per cent higher in these ingredients than would be permitted in steel for American explosive shells.

In the few German shells which showed any trace of copper, the content would have been allowable in American practice, but quite evidently the presence of this element is not considered of any particular advantage, for by far the larger majority of the shell fragments showed no trace of it.

In the case of nickel, which may be present according to American specifications in the proportion not exceeding 0.50 per cent, no trace was found in any of the analyzed shells. This would seem to show that the addition of nickel is not considered indispensable by them.

Table 2 gives the allowable chemical variations which would be permitted by the Germans, basing the percentages upon the twenty-one typical shells which were carefully analyzed. The establishment of definite specifications on twenty-one analyses could not, of course, be taken as conclusive evidence that the variations shown may not be exceeded, but, as there is no reason to assume that the fragments examined were other than typical, such specifications may be safely taken as acceptable to the war lords. These allowances may be more exacting than those permitted by the German government, but they are certainly not more liberal.

Table 2

Probable German Specifications

	Minimum Per Cent	Average Per Cent	Maximum Per Cent
Carbon	0.40	0.75	1.12
Manganese	0.40	0.93	1.40
Silicon	0.00	0.28	0.60
Sulphur	0.00	0.05	0.085
Phosphorus	0.00	0.06	0.105
Copper	0.00	...	1.00

Should some such specifications as these be adopted by our Government, it would make available a considerable tonnage of steel which to-day cannot be used in the production of high-explosive shells. With a larger steel supply available, the production of shells could be greatly accelerated. There is no question that shells could be produced in this country quite equal to those made in Germany—a quality of shell which heretofore has proved quite efficient.

The wide variations in the composition of German high-explosive shell steel indicate that not only are no exact chemical requirements imposed, but also indicate the strong probability that the requirements for acceptable shell steel are not based on chemical but upon physical properties. This theory is indorsed to some extent by the French who lay particular stress on exhaustive and reliable physical tests while imposing little limitation as to chemical composition.

The chemical composition of steel can only be taken as indicating what its physical properties *may* be. It cannot be accepted as a definite indication, and for this reason all governments require confirmatory physical tests. It would seem the part of wisdom, therefore, to rely more on physical tests and impose less strenuous chemical requirements.

A shell possessing the requisite physical properties must be satisfactory from the point of view of destructiveness, irrespective of its chemical composition. Some such reliable test as the hydraulic test required by the French government for its high-explosive shells would appear to be the prime necessity. This test may be easily made and would automatically establish sane chemical requirements. Similar practice on the part of our Government would accelerate production, cheapen cost of manufacture and make available much steel which is at present barred by specification.

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Chemical Engineering Aspect of Renovating a Sulphide Mill*

By Hugh K. Moore

In the winter of 1909 and 1910 I was called to La Tuque, P. Q., Canada, in order to render what services I was able in renovating and reconstructing a pulp mill running on the so-called sulphate process. The word sulphate is a misnomer and I have always objected to the term, which even though accepted in the trade as descriptive of the process, really is not descripive of the process by which the pulp is made. As you all know, the so-called sulphate process is so named from the large use of sulphate of soda as a raw material. This sulphate of soda, however, is not used directly in cooking, as it is reduced beforehand to sodium sulphide, sodium hydrosulphide, caustic soda and carbonate of soda. The essential difference between this process and the soda process is the sulphide content of the cooking liquor. The name sulphide then is descriptive of this particular process of making pulp and is as correct as "soda" and "sulphite," names which clearly designate the other well-known processes by which pulp is made.

Now I wish to say, lest you expect too much, that when I went to La Tuque I did not know what a sulphate mill was and understood nothing about the process; and, furthermore, I was called upon so suddenly that I had not time to inform myself as to the nature of the process before I started.

Before going into details as regards the processes and innovations a few remarks on the scope and limitations of this article may not be out of place. In the first place, this being about one particular mill instead of several mills, I purposely suppress all data on costs, maintenance, repairs, etc., neither shall I give any data as to yield per cord of wood, or salt cake, fuel, labor, repairs, etc., etc., per ton of pulp. Neither shall I give any figures on any of the installation costs. In stating the facts and methods of overcoming the difficulties I want it to be particularly understood that I am not claiming credit for all the different changes made. Many of these I made, but many were made by Mr. Brown, Mr. Lovett and others, many were combinations of ideas of all, and it would puzzle a Philadelphia lawyer to assign to whom credit for certain of these changes should be given. The idea in mind is not to assign credit to any one person or group of persons, but to show how a knotty problem was tackled and solved.

RÉSUMÉ OF SO-CALLED SULPHATE PROCESS

In order that those who have no more knowledge of the workings of the sulphide process than I had at the start (if there be any such) may have an understanding of the difficulties encountered, I think I had better give a short résumé of what the sulphide process is.

Woods of the conifer type are mechanically partitioned to form chips about ¾ in. square and ⅛ in. thick through a chipper, and these are run into a digester. After the digester has the required amount of chips the cooking liquid or alkali is run in, the digester is closed and heated by live steam, keeping the pressure on top of the digester during the cooking at 90-100 lb., relieving the excess of liquor and steam which are separated in a separator and blowing the steam into water to heat it so that it can be used in washing the pulp. When the digester is cooked it is connected with tanks and blown. The steam is blown off through vomit stacks, the liquor drained through false bottoms and the pulp washed according to the principles of systematic counter-current extraction. Now, owing to the propensities of this liquor for foaming the ordinary evaporator was not thought available so the liquor was passed through a disk evaporator, the source of heat being the waste gases from the steam boilers. The disk evaporator in brief is made of hundreds of pieces of iron plates set around a revolving shaft. As these disks revolve they dip into the liquor, then emerge from the liquor with a film of liquor thereon. The hot waste gases from boilers pass over these films evaporating the water. By having several of these in series and enough waste heat you can progressively concentrate the liquor. After passing through the disk evaporators heated by furnace gases the partially concentrated liquor passes another set of disk evaporators heated by gases from the incinerator. By this means it is possible to concentrate the liquor to 20 deg. Bé., where mechanical troubles place a limit to this method of concentration. From the disk evaporator it runs to an incinerator which is simply a brick-lined rotary furnace. The remainder of the liquor is evaporated and the residue charred so that it comes out as black ash which runs from the end of the incinerator on to the floor. The source of heat is the white-hot gases from the smelting furnace. This black ash is then shoveled over, sulphate of soda added thereto and thoroughly mixed therewith. Wood is now thrown into the smelting furnace and this black ash shoveled on top of the wood. Air from a positive blower is injected about 15-20 in. from the bottom of the furnace and the black ash burned, reducing part of the sulphate of soda to sulphide of soda according to the following equations:

$$Na_2SO_4 + 4C = Na_2S + 4CO.$$
$$Na_2SO_4 + 2C = Na_2S + 2CO_2.$$

Also part is reduced to carbonate of soda with small amounts of caustic soda and sulphate of soda passing through unchanged. The soda content in the black liquor is mostly reduced to carbonate of soda though part is also reduced to sulphide of soda. The molten alkali liquor runs from a spout into a dissolving tank in which is an agitator, while the hot gases pass through the incinerator charring the carbonaceous residue, making black ash in the front part of the incinerator and evaporating water in the further end of the incinerator, thence going through the disk evaporators and out of flue as above described.

This liquor in the dissolving tank is pumped to the alkali room, where it is tested and the requisite amount of lime is added whereby the sodium carbonate is converted to caustic soda. This is decanted by allowing the calcium carbonate to settle and withdrawing the supernatant liquor by means of a siphon. The first two washings are added together while the weak liquor of the last washings are pumped to the dissolving tank, and this constitutes the liquor in the dissolving tank into which the molten alkali runs as above stated. The strong washings constitute the cooking liquor for the digester, though some strong black liquor may be added as a diluent.

*A paper read at the Ninth Semi-annual Meeting of the American Institute of Chemical Engineers, Buffalo, N. Y., June 21, 1917.

This, in brief, is a description of the chemical end of the sulphide process.

DRAWBACKS OF PROCESS

Now let us consider what is wrong about the above process from the standpoint of a chemical engineer.

The process being a cyclic one, it obviously makes no difference at which point we start so long as we complete the cycle. Accordingly, I shall start with the evaporation of the liquid.

(1) From the above it will be seen that the process described is one of direct evaporation, the only good reason for the same being the difficulty of accomplishing it by multiple-effect evaporation. It will be noticed that there is a consumption of wood in addition to the heat evolved from the solids of the liquor itself. This consumption of wood I wish to state is in order to get over *mechanical* difficulties rather than an absolute necessity. The consumption of wood is small in amount and is well paid for in the increased production and saving of labor. Even if the sources of heat for evaporation were entirely waste heat, *i.e.*, heat which cannot be recovered and used in other parts of the mill, there is still a sound basis for putting in a multiple effect system, and those who argue to the contrary have an incomplete understanding of the problem involved. Suffice to say for the present that for every pound of solid matter in this liquor there are 5000 B.t.u., which is sufficient not only to do its evaporation but furnish heat to *eliminate the wood bill* and materially reduce the amount of coal consumed in the boilers.

(2) The disk evaporators get out of order and are a constant source of expense. The liquor has a tendency to polymerize and this clogs the disk evaporators. This polymerization is due to the hot flames through which it passes, not its concentration.

(3) The variations in the original strength of the black liquor are passed right on to the incinerators, which are unable to take care of these variations.

(4) The incinerators have a habit of "ringing up" in the inside, one side of the ring having molten alkali, the other side of the ring having black liquor. Now when this ring breaks the liquor runs on top of the molten alkali and an explosion follows. If this ring is located near the end the chances are that one or more men go to the hospital for burns, and the fear of things like this happening tends to prevent the keeping of men long enough in this department for them to become expert.

(5) The unevenness of the fire in the smelting furnace can only have one result, viz., the rapid deterioration of the furnace, not only from expansion and contraction, but also from the stuffing action of the sodium sulphide sublimed with sodium carbonate followed by the oxidizing action of the air under these intermittent conditions of running.

(6) The fine particles of salt cake and alkali are carried from the furnace through the incinerator and disk evaporators and lost with the exit gases.

(7) The separation of the carbonate of lime in the causticizing room takes a very large equipment and is troublesome in the extreme if the liquor happens to contain even a small per cent of iron sulphide. It usually takes six hours to settle a tank once and the heat lost is considerable of an item. The chances of losing alkali in the sludge are considerable, either through accident or neglect of duty.

(8) The sludge, which has a value in itself, is lost and may be treated for lime if so desired.

(9) There is also the possibility of the lime getting into the pulp through careless siphoning here.

(10) The steam, which is separated from the relief of the digesters being blown directly into the water which washes the pulp, blows many impurities therein, which gives the pulp, and consequently the paper made therefrom, an odor which prevents it being used for some purposes; for example, flour bags.

(11) This relief contains somewhat over 200 gal. of turpentine a day which is equal in quality to the best gum turpentine. By the above method all this turpentine is lost.

(12) Now taking up the process of blowing the digester we find that a considerable amount of pulp is blown through the vomit stack and lost.

(13) Every digester blown discharges 18,000 lb. of steam into the atmosphere, the heat of which might be advantageously recovered and used in the mill.

(14) When we come to the washing of the pulp we find the process slow and cumbersome. A process full of inherent difficulties of clogging, which either means a check in production or a waste of alkali. Both of these usually occur.

(15) An appreciable amount of pulp is carried away in the digester liquor.

METHODS OF OVERCOMING DRAWBACKS

Having pointed out the objectionable features of the process as ordinarily carried out, let us consider the methods by which they were overcome and the experiments relating thereto.

EVAPORATION

As before stated, this black liquor is very cantankerous, foaming under the least provocation. Bearing this in mind we built a multiple effect evaporator specially designed to overcome this fault. At first we could not run it at anywhere near its theoretical capacity on account of the foaming propensities of the liquor. Among the experiments we tried was to run the foam and steam through a specially designed centrifugal steam separator run at a very high velocity by a direct-connected steam turbine, the object being to throw the separated liquor through periphery, letting the steam pass through the center to the next effect. This worked very well when the bubbles of foam were large, but when they were small and consequently compact and heavy there was not enough power in the turbine to carry on this increased amount of work. Neither was it advisable to make larger turbines because the power required was so great that the steam consumption would be so great that most of it would have to be wasted as only a small portion could be used in the evaporators.

We finally carried the liquor only about 1½ to 2 in. in the tubes in the first effect, 6 in. in the second effect, and increasing heights as the concentration proceeded. The principle of this objection was that foam was constituted of a globule of steam surrounded by a heavy film of liquor, and that if we could produce the foam and evaporate off the water in the film to make it break we should accomplish our purpose. Now the height at which the liquor stands in the tube limits the quantity of the resulting foam, other conditions, such as steam pressure density, etc., etc., being equal. Now this foam shooting up through the remainder of the hot tubes has

its films transformed into steam, so that there is so much steam and so little film that they readily separate the steam passing to the next effect and the liquor is returned to where it finds its way to the next effect. Care, however, must be taken that too much of the foam shall not be evaporated as gumming up of the tubes results. The levels were for a time maintained by specially designed floats and this was continued until the men got so expert that they were no longer necessary. Large separators were put between each effect to catch any occasional foam and return it to its proper effect. A solenoid was installed which could be regulated so as to return any liquor having over a predetermined strength, and this could be regulated with the greatest nicety. Owing to the mercaptans given off in the liquor which have a very corrosive action we found that we had to redesign many parts of the vacuum pump and substitute rubber rings for the cast-iron piston rings. We got rid of the calcium sulphate which precipitated on tubes by surrounding the tubes with water and putting an acetylene flame down through the tubes, thereby heating the calcium sulphate and cracking it off without overheating the tubes. What with redesigning condensers and other apparatus we finally evolved an evaporator of six effects capable of evaporating considerably over 4,000,000 lb. of liquor a day to a consistency of from 33 deg.-35 deg. Bé., and we have now obtained a uniform liquor. These multiple-effect evaporators made the disk evaporators obsolete and they were scrapped and all the resulting repairs, labor and shutdowns eliminated.

ELIMINATION OF INCINERATOR AND EXPERIMENTS RELATING THERETO

Now, having obtained a uniform concentrated liquor, we are in a position to start work on the elimination of the incinerator. In order to do this several preliminary experiments became necessary which at first sight may seem to have no connection therewith. Previous experiments had shown that iron would not stand either the alkali liquor or the alkali gases under the usual conditions. Experiments were now conducted to see if it would withstand these if kept at temperatures not exceeding 400 deg. Fahr. The preliminary experiments seemed to show that it would, so we then obtained a steam boiler, erected it and built a smelting furnace in front of it, passing gases under the boiler and through the tubes just as if we were burning coal. Before starting we had an inspector from the Hartford Insurance Company go over the boiler and test it thoroughly. We then operated this boiler under 100 lb. pressure for about a year under these conditions, and had a reinspection by the same man and found that it had not deteriorated under these conditions any more than the corresponding deteriorations of a boiler running with the ordinary coal fire. Of course, we had trouble with salt cake subliming and vaporizing and condensing on the boiler and fouling the tubes, but we at this time were not interested so much in this aspect of the case as we were in ascertaining if the boiler would stand up under these conditions.

Having satisfied ourselves absolutely that the boiler would stand up, we next tackled the problem of burning the liquor in the furnace in order to save the heat in the boiler.

Now a few words as to the nature of the residue obtained from evaporating the water from the black liquor. This is a dark-brown plaster or semisolid, according to the temperature. At temperatures of steam it melts forming a sticky, gummy mass, impossible to handle in any known manner. Even in the cold it cannot be chipped, disintegrated, handled or conveyed in any known manner, and two lumps placed one on the other will nevertheless coalesce into one another. It is a most difficult substance to handle. It was thought that if this could be absorbed in sawdust, that we could evaporate the water with furnace gases. We put in a drying tower composed of shelves, blowing the sawdust alternately in and out from shelf to shelf, running the black liquor thereon and passing the flue gases over it from bottom to top. The dried, impregnated sawdust was then carried by conveyors to the furnaces. This worked as long as there was sawdust enough from the sawmill. But there was never sawdust for more than 20 per cent capacity. We then tried hogging wood, but this got us into trouble at once, and it was found that owing to the low absorptive capacity of the hogged wood that it was impossible to build a drying tower strong enough to deal with the resultant sticky mass. We went from 6-in. I-beams to 15-in. I-beams, but found we would twist off the latter almost as rapidly as the former. We even tried using black ash as an absorbent for the black liquor. When it worked the reduction in the furnace was excellent, though it was found the resulting amount of iron in the liquor produced made the problem of settling out of the lime sludge a very difficult one. However, owing to mechanical troubles, this was found, as above stated, absolutely impracticable and had to be abandoned.

We had some time previously tried to atomize this liquid into a hot flame, hoping to evaporate the water from it and have it charred by the time it landed 7 ft. away, but without success, and the reason is very clear, if one considers the difficulty of getting a fine spray with this liquor.

A simple calculation will show that for the evaporation of the water alone, say nothing of charring, the diameter of these droplets could not be over 0.0029 in. if evaporated in gases at 2000 deg. Fahr. traveling a distance of 7 ft., heat abstracted from gases 0.005 in. thickness surrounding the droplets during the entire passage through the furnace, liquor 50 per cent water and temperature 210 deg.

Now, as a matter of fact, this liquor cannot be atomized to this fineness or anywhere near it, so though we started with a good fire we soon put it out by plastering it over with this liquor.

Now, after this drying tower proved such a failure, our minds turned back to our atomizing experiments. If we could only atomize finer and get some additional heat, we figured that it ought to be done this way. There was some chance that by experimenting we might make an improvement in atomization, and it occurred to us that the additional heat might be obtained from radiation. Stefan's law naturally occurred to our minds at this stage of the proceedings, and we at once collected all the data relating thereto to see if we could make a practicable use of the same.

This law is in brief that the heat radiated from one black body to another varies directly as the difference of the fourth powers of the absolute temperature. This may be expressed as follows:

$E = K(T_2^4 - T_1^4)$ where E is the total energy radiated and K a constant, T_2 and T_1 being absolute temperatures, of which T_2 is the higher.

It is not our intention in this paper to drag it out to an interminable length by going into the mathematics of this law, which have been so well established that any one interested may refer to the reference given at the end of this paper.

We have, however, calculated certain results and submit these in the forms, viz., the tabulated and the graphical chart. The calculations finally reduce down to the following simple formula:

B.t.u. per sq. ft. per min. $= 2.66 \times 10^{11} (T_2^4 - T_1^4)$.

CALCULATIONS
ASSUMING STEFAN'S LAW FOR BLACK BODIES
English Units $K = 2.66 \times 10^{11}$ B.T.U. per min. per sq. ft.
B.T.U. $= K(T_2^4 - T_1^4)$
Case I. $T_1 = 600°$ F. abs. T_2 varies

T_2	T_1	T_2^4	T_1^4	$T_2^4 - T_1^4$	B.T.U.
800°	600°	409×10^9	1295×10^8	279.5×10^9	7 43
1000		100×10^{10}		870.5×10^8	23 15
1200		2075×10^9		194.6×10^{10}	54 80
1400		384×10^{10}		371×10^{10}	98 80
1600		655×10^{10}		642×10^{10}	171
1800		105×10^{11}		103.7×10^{11}	276
2000		160×10^{11}		158.7×10^{11}	422
2500		390×10^{11}		388.7×10^{11}	1034
3000		810×10^{11}		808.7×10^{11}	2150
3500		150×10^{12}		150×10^{12}	3990
4000		256×10^{12}		256×10^{12}	6810
4500		409×10^{12}		409×10^{12}	10900
5000		625×10^{12}		625×10^{12}	16600
5500		915×10^{12}		915×10^{12}	24300
6000		130×10^{13}		130×10^{13}	34600

CALCULATIONS
ASSUMING DIFFERENT LOWER TEMPERATURES FOR DIFFERENT CASES
Case II, $T = 500°$ abs. Case III, $T_1 = 700°$ abs. Case IV, $T_1 = 800°$ abs.
Case V, $T_1 = 1000°$ abs.

Case II		Case III		Case IV		Case V	
T_2	B.T.U.	T_2	B.T.U.	T_2	B.T.U.	T_2	B.T.U.
800	9 20	800°	4.5	800°	0	800°	
1000	24 90	1000	20.2	1000	15.8	1000	
1200	43 50	1200	48 8	1200	44 3	1200	28 6
1400	100 49	1400	95 7	1400	91 2	1400	75 5
1600	172 50	1600	167 9	1600	163	1600	147 5
1800	278	1800	273	1800	268	1800	252 5
2000	424	2000	419	2000	414	2000	399
2500	1034	2500	1030	2500	1027	2500	1001
3000	2150	3000	2147	3000	2143	3000	2125
3500	3990	3500	3985	3500	3980	3500	3970
4000	6810	4000	6810	4000	6810	4000	6800
4500	10900	4500	10900	4500	10900	4500	10880
5000	16600	5000	16600	5000	16600	5000	16600
5500	24300	5500	24300	5500	24300	5500	24300
6000	34600	6000	34600	6000	34600	6000	34600

In order that there may be no mistake as to what radiant heat is I will state that it is the heat which passes from a body of higher temperatures to a body of lower temperature through an intervening gas without heating that gas. Thus the heat of the sun heats the earth without heating the intervening air. The earth in turn heats the air. The so-called steam radiator heats by convection, not by radiation. It must be borne in mind that this is not a simple process of evaporation and that this is not the main object in view. The main object in view is the recovery of the alkali present in the digester liquor and that this must be a reducing process.

This liquor after the water has been evaporated analyzes 45 per cent ash and 55 per cent combustible, which is spoken of in the paper as lignin, though it contains sugars as well as lignin, the approximate formula for which being $C_{15}H_{22}O_{11}$. This so-called lignin contains about 36.2 per cent combined water. Analysis shows that 2 lb. of the 50 per cent liquor contains 1 lb. water of solution, 0.2 lb. of combined water and 0.35 lb. of carbon, 0.45 lb. of ash. For this amount of liquor 0.14 lb. of salt cake may be added.

The heat required for evaporation and combustion may be calculated to have the following distribution:

B.t.u. required to evaporate 1 lb. water at 212 deg.	= 1052
B.t.u. required to raise this to 1600 deg. Fahr.	788
B.t.u. required to raise combined water to 1600 deg. Fahr	157
B.t.u. to raise products of combustion (12 per cent CO_2) to 1600 deg. Fahr.	2918
B.t.u. required to melt 0.45 lb. ash in liquor.	164
B.t.u. required to raise 0.45 lb. ash to 2000 deg. Fahr.	43
B.t.u. required to melt 0.14 lb. salt cake.	51
B.t.u. required to raise this to 2000.	13
B.t.u. required to reduce 0.59 lb. of Na_2SO_4 according to following equation: $Na_2SO_4 + 2C = Na_2S + 2CO_2 =$	146
	5332
B.t.u. figuring loss through furnace walls 10 per cent	533
Total heat	5865

It will be seen from the above that the heat in the liquor, viz., 5000 B.t.u., falls considerably short of the theoretical heat needed to carry on the reaction, and that it is this deficiency which must be supplied by radiant heat.

On the other hand it will be seen that a part of this heat is available for making steam if a steam boiler is placed in the pathway of the hot gases.

If we reduce the gases from 1600 deg. to 500 deg. we get:

B.t.u. from superheated steam	610
B.t.u. from products of combustion	2138
Total B.t.u. available for making steam	2748

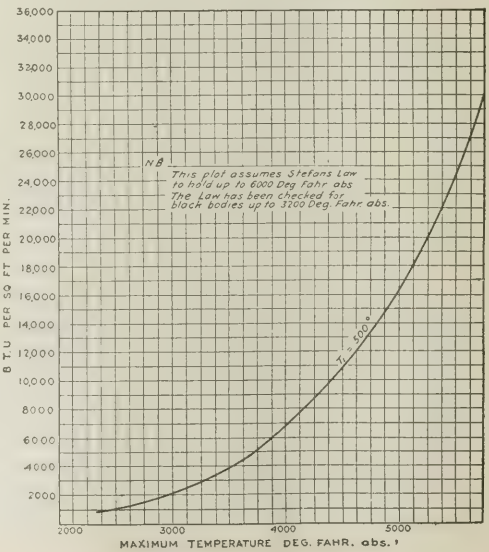

FIG. 1—CALCULATIONS, ASSUMING STEFAN'S LAW

Now we come to the problem of making up the deficiency. There are several ways by which this might be done, but only a few are practicable. If we had plenty of cord wood we could make it up in this way, and, in fact, we did at first. The results, however, were not satisfactory from the reduction side of the case. Coal can be atomized in the furnace and burned, but as all coal contains iron, it is objectionable on account of the difficulty of settling of the alkaline liquors which is occasioned by the iron. Furthermore, the coal contains ash which uses up the alkali, forming silicates and aluminates of soda, etc. It is also not satisfactory from a reduction point of view, as it requires an oxidizing flame.

Atomized crude oil was also tried, and though this gave a very hot flame furnishing the necessary amount of heat, it is not satisfactory from a reduction standpoint. Furthermore, the vaporization of the oil produces a cool zone in the place where it is necessary to have a hot zone tending to chill the smelted effluent.

Producer gas seems at present to be the most satisfactory way of supplying the extra heat needed. This enters the furnace hot and quality and quantity of the gas can be easily regulated. By constantly feeding the producer, we get a gas containing a large quantity of illuminants which are heated to high temperatures upon combustion of the gas and radiate heat to the particles of liquor to be evaporated, and these can be heated to a very high temperature by the burning of the already hot gas furnishing more illuminants.

Now if you will consider the following reactions, I think you will see the utility of this gas for reduction purposes:

$$\underset{328}{Na_2SO_4} + \underset{89}{2C} = \underset{194}{Na_2S} + 2CO_2 = -45.$$

$$\underset{328}{Na_2SO_4} + \underset{89}{4C} = \underset{116.5}{Na_2S} + 4CO = -123.$$

$$\underset{328}{Na_2SO_4} + \underset{22}{4CH_4} = \underset{89}{Na_2S} + \underset{121}{2H_2O} + \underset{97}{CO_2} = -43.$$

$$\underset{984}{3Na_2SO_4} + \underset{88}{4CH_4} = \underset{267}{3Na_2S} + \underset{484}{8H_2O} + \underset{116.5}{4CO} = -204.5$$

$$\underset{2296}{7Na_2SO_4} + \underset{106}{4C_2H_6} = \underset{623}{7Na_2S} + \underset{776}{8CO_2} + \underset{726}{12H_2O} = -277.$$

$$\underset{1640}{5Na_2SO_4} + \underset{106}{4C_2H_6} = \underset{445}{5Na_2S} + \underset{726}{12H_2O} + \underset{232}{8CO} = -343.$$

$$\underset{328}{Na_2SO_4} + \underset{89}{8H} = \underset{242}{Na_2S} + 4H_2O = 3.$$

$$\underset{328}{Na_2SO_4} + \underset{116}{4CO} = \underset{89}{Na_2S} + \underset{388}{4CO_2} = 33.$$

The numbers given in the above equations are in large calories per gm. molecular wt. taken.

It will also be seen that in all cases except the last two the reaction is endothermic. In the last two, viz., saltcake and hydrogen, and saltcake and carbon monoxide, the reaction is exothermic. Now if we could have either pure carbon monoxide or pure hydrogen come in contact with molten saltcake, we should have a reducing action which would not chill the molten liquor so as to congeal it.

In order that there may be no misunderstandings, I want to say that the operations mentioned in regard to reduction in this paper must not be considered as taking place on pure sodium sulphate nor should the resulting product be considered as pure sodium sulphide. In every case we have a mixture of several ingredients, viz., sodium carbonate, sodium sulphate, sodium sulphide and probably a little sodium oxide. Sodium sulphide pure does not melt at 2000° C. and in order that this should run at ordinary temperatures it must be dissolved in other salts.

Now in the above figures we have figured the saltcake as if all was reduced by the carbon in the lignin liquor. We did this in order to show the distribution of heat and the total heat consumed. As a matter of fact, however, I doubt if very much of this salt is reduced by the carbon of the lignin as the lignin is burning in an oxidizing atmosphere and any sodium sulphide reduced here from contact with the heated carbon would to a large extent be oxidized to sulphate of soda. In fact there is a considerable amount of sulphate of soda found in the smelted effluent of the furnace. The reduction caused by the lignin may be greatly increased by the producer gas. This has been shown many times by stopping temporarily the gas and the liquor and testing the effluent. The reduction of this gas was so marked that many experiments were conducted, the main object being to obtain a better mixture of this gas with the effluent. In all these experiments the reduction was markedly increased but most of them were abandoned owing to mechanical difficulties which developed.

CALCULATED AMOUNT OF COAL TO BE BURNED IN PRODUCER

The question now arises as to the amount of coal necessary to be burned in a producer to furnish the required liquor per ton of pulp produced in the mill. From data obtained we find a coal which analyzes as follows:

	Per cent.
Fixed carbon	53.34
Volatile matter	39.25
Moisture	2.66
Ash	4.75
Total	100.00

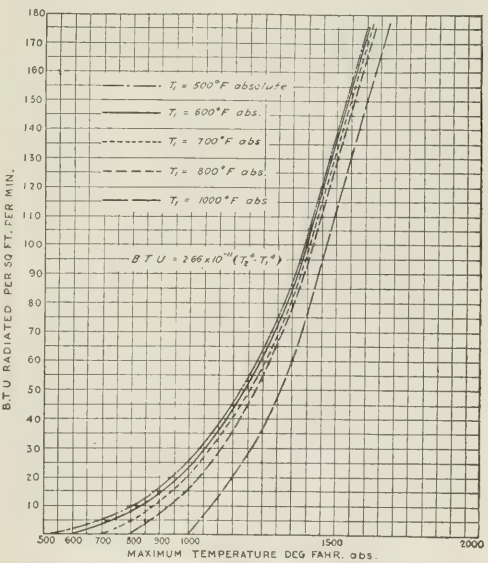
B.T.U. RADIATED PER SQ. FT. PER MIN.
MAXIMUM TEMPERATURE DEG FAHR. abs.
T_1 = 500°F absolute
T_1 = 600°F abs.
T_1 = 700°F abs
T_1 = 800°F abs.
T_1 = 1000°F abs
B T U = 2.66 x 10⁻¹² (T_2^4 - T_1^4)

FIG. 2—CALCULATIONS, ASSUMING VARIOUS LOWER TEMPERATURES

and which has an ultimate analysis given as follows:

	Per cent.
Carbon	73.11
Hydrogen	5.88
Nitrogen	2.10
Oxygen	9.24
Moisture	2.66
Ash	4.28
Sulphur	1.73

This will give a producer gas which analyzes as follows:

	By Vol.	By Weight.
Carbon dioxide	3.9	7.32
Ethylene	3.2	3.75
Oxygen	0.1	0.13
Carbon monoxide	24.6	28.86
Methane	3.8	2.62
Hydrogen	17.7	1.51
Nitrogen	46.7	55.81
	100	100

If we assume the gas comes from the producer at 1200° F. and that we burn it with the theoretical amount of air we find the following amounts and distribution of heat for 100 lb. of gas:

Heat of combustion of 3.75 lb. ethylene	77,560	
Heat of combustion of 28.86 lb. carbon monoxide	126,200	
Heat of combustion of 2.62 lb. methane	56,190	
Heat of combustion of 1.51 lb. hydrogen	79,230	
Total	339,180	
Sensible heat 7.32 lb. carbon dioxide	2,228	
Sensible heat 3.75 lb. ethylene	1,820	
Sensible heat 0.13 oxygen	34	
Sensible heat 28.86 carbon monoxide	8,533	
Sensible heat 2.62 methane	1,869	
Sensible heat 1.51 hydrogen	6,494	
Sensible heat 55.81 nitrogen	16,500	37,478
Total		376,658

Now the simplest method of getting the heat radiated is to find the heat leaving in the products of combustion and subtract this from the total heat.

In doing this the following formulas are used:

$(2405+.0000119t)t$ = B.T.U. for 1 lb. N.

$(.19+.00006t)t$ = B.T.U. for CO_2.

$(.2104-.0000187t)t$ = B.T.U. for 1 lb. O.

$(.2405+.0000119t)t$ = B.T.U. for 1 lb. CO.

$(.42+.000103t)t$ = B.T.U. for 1 lb. steam.

Now if we assume that owing to radiation and convection the gases are reduced to 1600° F. going over the bridge wall we have a basis for getting the heat in the products of combustion. A simple calculation shows that for every 100 lb. of gas entering the furnace we have a total of 327 lb. going over bridge wall distributed as follows:

174.48 lb. of nitrogen from air
55.81 lb. of nitrogen from producer

230.29 total nitrogen

11.79 lb. CO_2 from ethylene
45.97 lb. CO_2 from carbon monoxide
7.20 lb. CO_2 from methane
7.32 lb. CO_2 from producer

72.28 lb. total CO_2.

Total of 327 lb. of gases going over bridge wall for 100 lb. of producer gas.
4.93 lb. steam from ethylene
5.89 lb. steam from methane
13.59 lb. steam from hydrogen

24.42 total lb. steam.

Now if we calculate the heat in these given amounts of products of combustion we find we have:

	B.T.U.
Sensible heat of above steam at 1600° F.	19,260
Heat in 230.29 lb. nitrogen at 1600° F.	95,610
Heat in 72.28 lb. carbon dioxide at 1600° F.	23,080
Total heat in products of combustion of 100 lb. of gas at 1600° F. going over bridge wall	137,950

The excess of B.T.U. in the gases generated over those contained in the products of combustion at 1600° F. is found by subtracting 137,950 from 376,658 which gives us 238,708 B.T.U. for 100 lb. of producer gas available as radiant heat to heat the particles of liquor.

Calculation from the ultimate analysis of the coal and the analysis of the gas show 1 lb. of carbon produces 3.729 lb. of gas, or that for every pound of coal burned in producer 14,050 B.T.U. are liberated. Of course all this heat does not come from the coal, but part comes from the steam blown into the producer. Assuming a loss here also of 10 per cent through furnace walls, we have a loss of 1405 B.T.U. to take from the heat of radiation, neglecting heat losses from furnace. We find that we get 2387 B.T.U. per pound of gas to be supplied by radiation and convection to liquor and from this we get B.T.U. per pound of coal, 8851. Subtracting from the latter the 10 per cent heat losses for furnace, 1405, we get 7446 B.T.U. to be applied to making up the 865 B.T.U. deficiency not supplied by the heat in the lignin.

Now let us take as a unit a mill producing 100 tons a day of Kraft pulp.

Wood for making such pulp varies all the way from 45 to 52 per cent cellulose according to kind used and location grown. Let us assume a pulp containing 48 per cent cellulose and 52 per cent lignin. Then a unit of 100 tons pulp would have a content of 108 tons of lignin in the black liquor.

As the dried liquor is 45 per cent ash we find that our 100 tons of lignin makes 197 tons of dried black liquor. Then we have 394,000 of solid matter or 788,000 lb. of 50 per cent liquor.

Multiplying 394,000 by 865 and dividing by 7446 we find that we must have at least a producer capacity of 45,760 lb. per day per 100 tons of pulp. Of course there should be some leeway for poor coal variations in strength of liquor.

As a matter of fact we have found a 20 per cent margin above this not excessive when we consider the troubles eliminated by not running close to the theoretical point where any of the many variables tend to

upset the operation even to the extent of clogging the furnace.

TANGIBLE RESULTS FROM ELIMINATION OF INCINERATOR

As a result, however, of the above process we have been enabled to produce over 1600 horse-power from our liquor in addition to recovering the heat generated in the gas producer. We saved all our hospital bills and damages arising from explosions, we reduced the repair bills in the furnaces enormously, we saved all the repairs on incinerator and disk evaporators and the power required to run same, we saved about 60 men's labor in various departments and, above all, got an even, uniform production of quality never obtained before. In addition to the above it alone was the means of increasing the production many times.

KEEPING BOILER TUBES CLEAN

We have already mentioned that the boiler tubes in the preliminary experiments got dirty from sublimed saltcake and carbonate of soda. The keeping of the tubes clean proved to be a much more difficult problem than we first thought. The sublimed saltcake first deposits on the tube as a powder, but if not removed the additional saltcake soon smelts the whole to a continuous lump almost impossible to remove. The obvious remedy was to blow the tubes often enough to keep this powder from accumulating on the tubes, but how to do this without affecting the operation of the furnaces was a problem. I might also add it is still a problem, for though we have a workable proposition I think there is still a large chance for improvement. If we opened the clean-out doors we spoiled our draft and consequently had to shut the furnace down. We tried automatic blowing, but these blowers would burn off in the vaporized alkali or plug up so we could do nothing. We even had doors made with a hole covered by a small door opposite each tube, but these were unsatisfactory in that we were blowing from the wrong end and the air or steam did not have force enough by the time it got to the fire end of the tube to remove the accumulation of salt and alkali. We finally evolved a scheme by rebuilding the back of the furnaces where we could have a slot on top covered by covers and a rake attachment locating the tubes horizontally. The tube blower was also graduated by a ratchet attachment to locate the tubes vertically. By this means the tube of each boiler is blown twice a shift. Each blowing takes twenty minutes and we run three shifts; it will be seen that two hours are required for each furnace for every twenty-four hours of operation.

ADDITION OF SALTCAKE

The next problem was the constant addition of saltcake in the required quantities to the liquor. We first tried putting the saltcake in the back of the furnace through a tube supplied with saltcake by means of a conveyor. This did not give us the results desired, inasmuch as this was not properly mixed with the liquor, and consequently a great deal passed through the furnace unchanged. In other words, our reduction to Na_2S was small and the desired liquor was not obtained. The next step was to put a horizontal agitating tank over each furnace and mixing the liquor and saltcake therein and supplying each furnace separately according to its consumption. This worked fairly well. The main objections to this was the increase in the amount of labor required and the clogging of the pipes with saltcake when it was necessary to close a valve. We were quite successful in the scheme described in U. S. Patent 1,130,317, Mar. 2, 1915, not described here on account of taking up too much space.

We finally evolved a scheme by which we put saltcake in a hopper from which it was carried to a grinder, elevated to a rotary screen and sifted, the fine particles going to a mixing tank and the coarse particles being returned to the grinder to be reground. The mixer tank was supplied with liquor from the storage tank installed to hold the evaporated liquor, and powdered saltcake added by calibrated diaphragms so that a given amount of saltcake was added for a given amount of liquor. The mixture was pumped to the furnaces through a pipe in which a very high velocity was maintained and the liquor not used in the furnaces was returned to the mixing tank also at a high velocity. The object of having a high velocity in the pipes is to prevent the saltcake, which is only slightly soluble in liquor of this concentration, from settling out. Special valves were designed on the outlets of this pipe so that they could be cleaned without stopping the operation and they were so set into the line as to prevent forming a pocket on the take-off. In addition to the above, many contrivances were adopted for handling this liquor, but as to describe them would stretch this paper to undue length I must omit them.

SETTING AND RESETTING BOILERS

Now, having described the amount of heat coming from the flue gases of the furnaces, it might be well to state the method of recovering the heat contained therein. Experiment had convinced us that the horizontal return tubular boiler was best adapted to our needs on account of the comparative ease, as compared with other types of boilers, by which the saltcake and soda could be removed from the tubes. This we set up following the standard accepted boiler setting. This was found to be a great mistake and the settings had to be entirely changed to meet the new conditions imposed on them. In explanation I wish to say that though saltcake, soda and sulphide of soda vaporize at high temperatures they may be sublimed at 1200° F. in a current of furnace gases. Now the shell of the boiler acts as a condenser and the hot molten alkali condensed forward of the peak in the boiler setting flowed forward into the furnace. But unfortunately all the vaporized alkali was not removed here, but a considerable amount was condensed on the boiler back of the peak and this either accumulated as a lake of molten alkali or gradually solidified or ran out of the clean-out door onto the blow-off pipes or the cement floor. I have at times seen streams of molten alkali as large as my arm so run out of these clean-out doors.

These furnaces had all to be rebuilt with a continuous slope from the clean-out doors to the furnace. Even the whole length of the shell of the boiler was insufficient to condense all the sublimed alkali and this would accumulate in the tubes at first as a powder, but if the tubes were allowed to get too dirty the powder being a nonconductor of heat insulated the boiler tubes and the next accumulation of sublimated soda landed in the tubes in a melted condition cementing this powder to a hard mass. Many and various were the schemes

tried to get over this trouble, and we are still experimenting.

DISSOLVING TANK LIQUOR

As previously stated, the smelt runs into the dissolving tank where it is dissolved in the weak alkali coming from the alkali room. Owing to the greater efficiency of reduction we obtained a dissolving tank liquor much stronger in sulphide content than ever obtained before. Owing to the elimination of the incinerator and the intermediate black ash process the sludge in the dissolving tanks is very much reduced and the pieces of half brick, stones, etc., are reduced to a minimum; thus the constant repairs of agitator arms, etc., were eliminated.

FLUE GASES

The gases from the smelting furnaces contain considerable quantities of alkali irrespective of whether the old or the new process just described is used. This alkali is in such a fine state of subdivision that it is practically impossible to remove it by any of the ordinary means. These gases were run through a tower filled with atomizers, filling the tower with a dense fog and yet the particles were so fine that they would not be precipitated. We finally decided to experiment with the Cottrell Process and made arrangements for the same with the Western Precipitator Co. Owing to the great quantities of moisture in our flue gases we were not very successful at first, inasmuch as the moist precipitate would short-circuit the apparatus. But after making many changes we finally evolved a modification of this process which works finely. This not only prevents a public nuisance but it yields large dividends from the saving of this precipitate.

FILTRATION OF DISSOLVING TANK LIQUOR

As stated before, the dissolving tank contains many impurities among which is carbon, furnace linings, iron sulphide, etc., etc. Now the treatment of this liquor depends on the question of whether or not you intend to recover your lime. If the lime is not to be recovered this liquor can be pumped directly to the causticizing tanks. If, however, it is the intention to recover the lime it is necessary to filter this liquor from all the suspended matter, otherwise every time the lime was recovered there would be an addition of these impurities which would make the recovery impracticable. We have found that the best way to handle this is through a filter press. Here, however, we run up against a great difficulty, though this first made itself apparent in the causticizing operation to be described later on. The canvas used in the filter press does not stand alkali and required renewal so often that it was a source of considerable expense. This difficulty was partially overcome by treating it with a special rubber solution, depositing the rubber on the canvas threads and yet leaving the cloth porous. There is still chance for improvement here. The liquor after being filtered is sent to the alkali room.

ALKALI ROOM

In this room the liquor from the dissolving tank is causticized. This room consists of a large number of settling tanks fitted with siphons, lime, baskets, agitators and steam pipes for blowing in live steam. Here the liquor is tested and the calculated amount of lime added to the slacking baskets, steam blown in and the tank agitated, after which the precipitated carbonate of lime is allowed to settle. The supernatant liquor is siphoned off and weak liquor added from a previous washing and the operation repeated. Finally, the fourth washing is done with water after which the sludge is sluiced. As will be seen this process involves a large installation and requires a considerable amount of steam as well as considerable amount of time. Now the time factor is important inasmuch as if anything happens so that you become short of cooking liquor the digester plant has to shut down more or less waiting for these tanks to settle. Furthermore, the very nature of the process is such that it invites waste by either not washing properly due to neglecting one washing or due to incomplete settling on account of trying to catch up with the digesters, or losses may occur easily by intentional or unintentional manipulation of the labor employed.

In order to eliminate these wastes a filter press was installed which enables us to dispense with the settling and leaves many of these tanks available for storage of liquor. The lime sludge can be washed in the filter press with much less water than is used in the decanting or settling process and may be washed much freer from alkali. Furthermore, if the dissolving tank liquor has been filtered the lime sludge is in a condition for recovery of the lime. This operation allows us to make a stronger alkali solution than we otherwise could, and consequently we can use more black liquor as a filter in our digesters later on. This also means less evaporation later on.

RECOVERY OF LIME SLUDGE

We have experimented quite successfully on the recovery of the lime sludge, but up to the present have not put in an industrial plant. As this is not operating on a large scale I will not go into this here, but may in a future paper show how this is done. The method which gives the greatest promise is the electric furnace method, whereby we get pure CO_2 and recover our lime. We have installed a large experimental electric furnace with this end in view and expect to work it when our water-power development is completed.

DIGESTER HOUSE

The alkali from the filter press goes to storage tanks and thence to the digesters already filled with chips, where it is mixed with a certain amount of black liquor (used as a filler). The digester is steamed and cooked in the usual way. We however, made one very important change here. Instead of blowing relief into water to heat it we constructed a condenser and condensed the relief after first having separated it from the liquor which is contained.

There were three objects in view here. First, there was a limitation placed on the use of our pulp for many purposes, owing to the odor in bags used for holding flour, etc. My experiments had convinced me that a lot of this odor came from the use of this wash water. To get rid of this odor was the primary object but of course we wanted to save the heat.

Turpentine Recovery.—Our experiments had also shown that this relief contained large quantities of turpentine which, with the exception of the odor, tested equal to the best gum turpentine obtainable and far superior to wood turpentine. We consequently constructed, in addition to the condenser and separator

plant previously mentioned, a turpentine plant in which we separated the crude turpentine, made refined turpentine and finally a plant for deodorizing it from the mercaptan smells which accompany it. We have not been able to completely remove the odor, but have so far succeeded that we are enabled to sell our whole production at good prices.

VOMIT STACK GASES

After a digester is cooked the charge is blown into tanks to receive the pulp and liquor and the liberated steam is allowed to escape through a vomit stack. A calculation showed that there might at times be as much as 18,000 lb. of steam liberated in the course of a five-minute blow. Now here is over 20,000,000 B.T.U. per blow going to waste.

To save this we designed special condensers to condense this steam and heat the condensing water so that it could be used for washing the pulp.

VOMIT STACK PULP

Experiments had also shown that this vast amount of steam carried along with it a certain amount of pulp which except for these experiments would have entirely escaped our notice. This pulp, however, which is of the finest quality and should be saved for its own value, must be removed from the vomit stack steam before it enters the condenser, otherwise the plugging of the condenser is liable to follow. To do this we designed a special separating device somewhat on the principle of the cyclone so commonly used in separating shavings from air. This, however, was made with a pipe in the center which was closed at the bottom and had holes in it near the top for the outlet of the escaping steam. The steam was blown in at a tangent to the separator and circulated spirally up the separator, plastering the pulp over the side by its centrifugal force while the steam, now freed from pulp, passed to the condenser. Devices were also arranged for washing this plastered pulp from the sides as soon as the blow was completed.

The above not only enabled us to save an appreciable quantity of pulp but furnished us with immense amounts of hot water practically free of cost, enabling us to make a better and cleaner pulp.

WASH ROOM

The pulp from the digester is washed in the usual manner, though even here we have devised a machine on the counter-current principles of washing which looks as if it would revolutionize the whole washing end of the business. At present it is too soon to say much about this.

LIQUOR FROM WASH ROOM

This liquor instead of going direct to the evaporators goes to a filter press, and it is found that we obtain a considerable saving in pulp. Not only this, but the removal of this pulp from the liquor makes a direct saving, not due to the pulp, but an indirect saving which is even of far greater importance. I refer to the trouble eliminated in the evaporator room by being freed from the accumulation of pulp in the last effort which seriously interferes with evaporation.

We have now completed our cycle, being back where we started. In the foregoing we have not taken into consideration all the departments of the mill. Many of these are undergoing changes, but enough has been said to show that the chemical engineer can play a most important part in the renovation of this kind of mill at least. My own personal opinion is that the chemical engineer has a great opportunity in any mill involving a chemical process. In closing I may say that the average manufacturer considers the chemist and the chemical engineer as non-productive labor and classes them with the office help. As a matter of fact, the chemical engineer can probably not only save him more money than any other department of his mill but also produce him more money.

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Chemists in War Service.—The American Chemical Society points out the advisability of following the lead of our Allies in assigning technically trained chemists to chemical service. Lacking an exemption of any group of men as a class, it is unofficially recommended that chemists of military age selected by draft and accepted for service should submit to their local boards a certificate from their employers or college as to their education and nature of present occupation, together with a request that they be allowed to continue in chemical work, either in private plants or in the military service. In any case, the secretary of the society should be promptly notified by members of any change in enrollment.

Operating Details of Zinc Retort Furnaces

By Edward Mackay Johnson

Superintendent Eagle Picher Lead Co.

LIGHT, VENTILATION AND SANITATION

Light, ventilation and sanitation all have at least an indirect bearing upon the recovery of zinc, and in designing a plant, or even in one already in operation, they should receive due consideration. While most of the furnace men do not work over five or six hours per shift as a rule, the rapidity with which they make up and charge a furnace has a decided effect upon the recovery of zinc. The men can do just as good, and at the same time faster work, provided their working conditions are favorable.

Work on the furnaces in the summer time is very hot and trying on the men at the best, and any relief in the way of improved conditions will not only add to their comfort, but will pay for the cost, both in the increased recovery of zinc and in retaining a more efficient organization. Considerable advancement has been made along these lines in the past two or three years by blowing fresh, cool air upon the men while at work during the hot months of summer. A number of the plants have also constructed convenient wash rooms. It is unfortunate, however, that the men in a good many cases have not shown their appreciation of the companies' endeavors to improve their conditions.

FURNACE WORK AND TOOLS—NATURAL GAS FURNACE

Head Charger.—The first duty of the head charger upon coming to work is to mark any bad retorts in the furnace. He then assists in drawing the first four sections of the furnace. As soon as the draw-car and blow-out shield (through which also the retorts have been "bumped") are out of the way, the charger, with a specially constructed scoop (Fig. 1), commences

FIG. 1—CHARGING SCOOP

charging the retorts with material from the charge-car, which travels on a near-by track parallel with the furnace. He should fill the retort from back to front without leaving any "nests" in the charge. Each retort should be "spieced" as soon as charged by inserting a small iron rod along the top of the charge to prevent the charge from blowing out. Each retort should be examined before recharging to see that it is neither cracked nor has a hole in it. The head charger and second charger work in turn, charging five retorts apiece as a rule. After the furnace is completely charged, the head charger cuts out the bad retorts, helps pull them out, and put in new ones. He should also look after changing any bad plates or pillars.

Second Charger.—The first duty of this man is to oversee and help to turn and mix the blue powder with the proper amount of coal and water, being careful to obtain a thorough mix. He now helps draw the first four sections of the furnace and assists in bumping out the retorts in the first section. He then alternates with the head charger in charging the furnace, and helps the stamper (the man behind the car) patch up any holes in the furnace as they go along. As the new retorts are placed, he stamps them with furnace mud.

Man Behind the Charge Car, or "Stamper."—While the first four sections of the furnace are being drawn, the stamper helps in any way he can, pushing the draw-car along, etc., and then he draws the remainder of the furnace down to the blue powder. He then works behind the charge-car, laying the condensers over by the furnace so that the "loamer," or man behind car, can place them upon the castings. The stamper now sets the condensers by placing the butt about an inch into the mouth of the retort, resting the small end or mouth of the condenser upon the "grasshopper" (a small casting somewhat resembling the leg of a grasshopper), adjusting the condenser in its proper plane with respect to the retort, and with the bottom of the condenser practically horizontal. Another important duty of the stamper, and the one from which he gets his name, is to stamp the furnace mud into the openings left wherever new retorts are put in. The stamping tool (Fig. 2) must be hot to prevent the clay from adhering to it.

FIG. 2—STAMPING TOOL

He also shovels one-half of any charge spilled during charging back into the charge-car. He goes ahead and draws the blue powder as soon as it is ready. With the aid of the "loamer" he scrapes off the luteing material from the castings, and cleans up the floor between the track and furnace.

Man Behind the Car, or "Loamer."—The loamer's duties consist of the following: He helps the stamper draw the furnace from the fourth section to the blue powder; places the condensers upon the castings; closes the spaces between the retorts and condensers with loam as the stamper adjusts them to position. The loam usually consists of about five parts coking coal, one part dirt and one part residue, mixed together and moistened with water. While loaming-up he also closes the mouth of the condensers with "stuffing," which may be non-coking coal or samplings from the mouth of the retort mixed with furnace tops. The loamer also helps the stamper scrape off the castings and clean up the floor between the furnace and charge-car track.

Chiseler.—This workman helps to turn the blue powder; chisels and pries the condenser loose from the retort with a chisel bar (Fig. 3); chips that part of

FIG. 3—CHISEL BAR

the broken condenser which contains material valuable enough to be retreated, breaks it up fine and turns it into the blue powder. He also cleans up the floor on the outside of the track and puts in six pans. He gets the clay from the pottery and wheels in the coal for the blue powder; hooks the burnt clay out from between the retorts that are to be changed; carries the pole to

take the new retorts from the preheating kilns to the furnace, and shovels one-third of the blue powder over by the furnace for the charges.

Blow-out.—The first duty of the "blow-out" is to clean the floor and dump the furnace pans. He then takes down the condensers as the chiseler cuts them loose, and samples the mouth of the retort—*i.e.*, he rakes out any oxide of zinc or the richest of the residue, which is nearly always at the mouth of the retort. He scrapes the samplings from off the castings upon the furnace pans, which material goes to the blue powder for the next shift. He pulls these pans out and sweeps up the floor as he goes along, leaving open the channels to the cellar.

He now proceeds to "blow out" the retorts by means of an iron pipe (Fig. 4) drawn to a point and perforated

FIG. 4—BLOW OUT HOSE AND PIPE

with small holes at the end, through which a spray of water under pressure issues. The pipe is inserted through the blow-out shield to the end of the retort with a firm, steady push. As the spray of water enters the hot residue, the rapid generation of steam causes an explosion on the inside of the retort, which ejects the residue from the retort against the shield, whence it falls into the cellar below. The blow-out also puts in the last four pans, shovels one-third of the blue powder over to a convenient place for the chargers, helps the bumper carry the retorts from and to the furnace by means of the goose neck (Fig. 5). He also helps to

FIG. 5—GOOSE NECK OR RETORT CARRIER

clean up the clay from in front of the furnace after the retorts are charged.

Bumper.—The "bumper" helps turn the blue powder, bumps the mouth of the retort free from any burnt loam, etc., and with the same tool (illustrated in Fig. 6)

FIG. 6—BUMPING TOOL

rakes any slag or residue that remains in the retort after blowing out. He works through a slot in the same shield used by the blow-out, alternating with the latter in his work. He cleans the castings after bumping with a hoe (Fig. 7), puts in the second six pans, shovels

FIG. 7—TOOL FOR RAKING OFF THE CASTING

over one-third of the blue powder to the charges, helps take out broken retorts and put in the new ones, and helps clean up clay, etc., after the retorts are all changed.

Condenser Boy.—The duties of the "connie" boy consist in scratching the blue powder and oxide of zinc from the inside of the condenser with an iron button riveted to the end of a light iron rod (Fig. 8). He also

FIG. 8—SCRATCHER BUTTON

bumps off any zinc crust or burnt loam from the outside of the butt of the condenser (Fig. 9), keeps the charge shoveled down in the charge car, and sweeps up the furnace floor outside the charge-car track. After the

FIG. 9—CONNIE BOY'S BUMPER

furnace is charged he keeps the condensers spieced up by introducing through the top of the stuffing a small iron rod drawn to a point. If, after spiecing, a flame shows at the butt of the condenser, he "patches up" or throws fresh loam around the place burning out. He screens the samplings and gets the stuffing ready. One condenser boy attends to two furnaces or one block after 11 a. m. The condenser boy as a rule uses the same buttons that the metal drawer drew the furnace with.

FIG. 10—TOOL FOR HANDLING CONDENSER

Metal Drawer.—The metal drawer, as the name implies, draws the zinc and scratches the oxide of zinc and blue powder from the condenser into a ladle by means of the scratcher button (Fig. 8). In the West he commences to draw the blue powder about 3.30 p. m., finishing about 4.30 p. m. At 4.45 p. m. he commences at the first section of the furnace and draws the charge through to the blue powder, finishing about 7.30 p. m. He makes the second draw in the same way, commencing about midnight and finishing about 3 a. m. The third or morning draw is made by the "half-shifters." The metal drawer should scratch the condenser clean, but should not pull any more hot residue (or "fire") from the mouth of the retort than is necessary to keep the zinc from freezing in the ladle. This should be specially guarded against if the ore carries much lead or iron, as these elements would then be unnecessarily increased in the spelter.

Stuffer.—As fast as the condensers are drawn, the "stuffer" stuffs and lights them, cleans up the scrap and piles the metal.

FIG. 11—TOOL FOR SAMPLING MOUTH OF RETORT

Day Fireman.—The day fireman has general supervision over his block and its workmen. He comes to work about 3.30 a. m. with the half-shifters, or the men who make up the furnaces. In addition to overseeing the work he works over the blow-holes and cleans out bad retorts that appear during his shift. His most important duty, of course, is the actual firing of the block. He therefore has to regulate the supply of air and gas by means of the main air gate and gas valve, and the small air "shievers" on the furnace.

It is almost impossible to describe the actual process of firing, and only a general idea can be given. The method of firing varies not only for different ores, but sometimes on the same ore at different plants. Assume that the furnace is practically worked off, and is at the critical temperature which the retorts will stand. If the night fireman has not already done so, the day fireman will somewhat reduce the air on the whole furnace as soon as he comes on duty by means of the main air gate, and if any sections of the furnace appear to be too hot he will also close the small shievers at those particular places. As the furnace is drawn, he "cuts-in" these shievers behind the draw-car, which operation necessitates reducing the volume of gas entering the furnace by means of the main gas valve. The small gas valves on the furnace are seldom used. As the furnace is charged the fireman opens up these shievers behind the charge-car, thereby burning the gas closer and more rapidly heating that part of the furnace which has been charged.

It is at this point that the firing may vary. In some cases the shievers are opened rather wide, in order to heat the charge rapidly and obtain a heavy flame at the mouth of the condensers in a short time, then "cutting-in" the shievers sufficient to properly regulate or settle this down. In some cases the shievers behind the charge-car are not opened so wide, thereby bringing the heat up more gradually, not permitting the heavy flame to appear at the mouth of the condensers. The main idea in either case is to so regulate the amount of air and gas entering the furnace to get the latter permanently adjusted for the shift, at the same time increasing the heat of the charge so that it is sufficiently worked off in the allotted time. The method of firing an ore depends on whether it is hard or soft, or gives up its zinc with difficulty or with ease.

In either case the day fireman usually has the furnace "settled down" between noon and 2 p. m., according to the nature of the ore and the time the men start and finish making up the furnace. After the furnace is settled down, the small shievers are not disturbed much. The furnace is kept gradually "coming" by means of opening the main air and gas valves a little from time to time as needed.

Night Fireman.—As a rule the night fireman simply continues to keep the furnace "coming" as above, or he may also open up the small shievers a little, his main object being to have the furnace (or at least the first four or five sections) so fired that very little flame is showing at the mouth of the condensers by the time the men come to work in the morning, which is about 4 o'clock.

In addition to firing the block, he oversees the metal drawing, stuffing the condensers, patching up and spiecing, and cleaning out any bad retorts that may show up.

COAL FIELD FURNACES

Hegeler Type.—As this furnace is charged from end to end, the same as in the gas-fired type, the furnace work and tools are very similar, so far as the writer's experience goes. The principles of firing are also essentially the same.

The main feature of this type of furnace is that the artificial gas generated from coal by means of a producer passes directly into one end of the furnace and out at the other without any regeneration, the waste heat being conducted under boilers at the end of the furnaces.

Neureuther Type.—There does not exist enough difference between the tools used by the men in making up this type of furnace and those used on the natural gas furnace to warrant further description. The details of the work are also practically the same, but owing to the fact that the whole bottom row of retorts is charged at one time, working from the bottom row to the top row, the general system varies somewhat.

In making up a furnace of 400 retorts it is divided into four machines, each of 100 retorts, and a crew of three men. Each crew makes up its part of the furnace practically independently of the other crews. In this type of furnace the retorts are changed first instead of after charging. The furnace, instead of being drawn from end to end in the morning by two half-shifters using a draw-car, is drawn by all of the half-shifters working at the same time. Hand ladles are used to make this draw. The furnace is therefore quickly drawn, requiring only ten or fifteen minutes. In this type of furnace instead of charging from cars the mix of ore and coal is strung along in front of and parallel with the furnace. While the residues are sometimes raked out of the retorts in the gas field, in this type of furnace they are always raked out regardless of the kind of ore smelted.

The foregoing practically covers the essential variations in the work upon that type of furnace which is charged and worked off from end to end, and on one that is charged from row to row, and the whole furnace worked off at the same time.

Henryetta, Okla.

The Action of Aluminium Chloride Upon Solvent Naphtha[1]

By Robert J. Moore and Gustav Egloff

The following paper is the application of information obtained in a previous work[2] on pure aromatic compounds to commercial sources of aromatics. The first paper dealt with the action of aluminium chloride upon pure benzene, toluene, xylenes, cumene and cymene. The starting oil used in the following work was a commercial solvent naphtha derived from the thermal decomposition of coal.

SOLVENT NAPHTHA USED

The solvent naphtha used in these experiments was the usual commercial product of approximately 65 to 70 per cent of xylenes and contained ethyl benzene, trimethyl benzenes and higher derivatives of benzene, traces of unsaturateds and paraffins with about two per cent of naphthalene and naphthalene derivatives.

DISTILLATION ANALYSIS

Specific gravity 0.868 at 15.5 deg. C.

The distillation was conducted in a standard 100 c.c. Engler flask.

Temperature Deg. C.	Per Cent by Volume
134.8	1st drop
135.0	0.6
140.0	47.3
145.0	79.4
150.0	85.6
160.0	93.0
170.0	97.7
180.0	99.1
181.0	Dry Point

[1]A paper read before the Industrial Section of the American Chemical Society at the Spring meeting in Kansas City, Mo., April 14, 1917.

[2]This journal, vol. XVI, 1917, Moore and Egloff.

Upon sulphuric acid treatment a lemon color was noted in the acid layer.

Experimental Procedure

The formation of benzene and toluene from solvent naphtha may be accomplished by the action of anhydrous aluminium chloride or by generating the aluminium chloride within the body of the liquid by passing hydrogen chloride gas over aluminium powder or filings in the presence of mercuric chloride. The formation of aluminium chloride within the body of the oil by passing hydrogen chloride over aluminium is enormously increased by the addition of a small amount of mercuric chloride which seems to be catalytic in its action.

Both methods of using aluminium chloride were tried in these experiments. In the anhydrous aluminium chloride experiment a charge of 5 per cent by weight of aluminium chloride was added to one liter of solvent naphtha. The distillation of the solvent naphtha was conducted in a round bottom flask of two liters capacity, with a Hempel column to which was attached a 24-in. Liebig condenser. The distillation was conducted so that in a 24-hour run 78.1 per cent of the liquid distilled over. During the distillation copious volumes of hydrogen chloride came over with some of the volatile aluminium chloride, which in part clogged the condenser tube, and a small quantity also separated out in the bottom of the receiving flask. The distillate was neutralized with a 10 per cent sodium hydroxide solution, washed and dried over fused calcium chloride. The residue in the flask upon cooling solidified in part to a heavy black tar, with a layer of lemon colored light oil upon the surface of the tar. This residue was shaken with sodium hydroxide and filtered free of aluminium chloride compounds of some of the hydrocarbons present and free carbon. The oil layer was separated, washed and dried. The dried oil was analyzed for its benzene and toluene content by a method devised by Rittman, Twomey and Egloff.[3]

In forming aluminium chloride within the body of the oil by the action of dry hydrogen chloride gas upon aluminium powder or shavings in the presence of a trace of mercuric chloride, a charge of one liter of solvent naphtha was used in the same flask as in the above experiment with a slight modification later described. One per cent by weight of powdered aluminium was added to the liquid and 0.1 per cent of mercuric chloride. A glass tube was passed through a hole in the cork extending to the bottom of the flask and attached to the hydrogen chloride generator. The hydrogen chloride was generated in a Freas apparatus by dropping conc. sulphuric acid of 1.84 specific gravity upon ammonium chloride. The gas was washed and regulated by a Dreschel wash bottle containing conc. sulphuric acid. The formation of aluminium chloride can readily be noted by a reddish flecking upon the sides of the flask. This reddish liquid soon colors the whole mass of solvent naphtha to a deep red, increasing toward a blackish looking mass.

The solvent naphtha is best added to the aluminium in the flask, covering it and then adding the mercuric chloride. The distillation was carried on over a period of twenty-four hours and yielded a distillate of 82.3 per cent of the initial charge of 1 liter. The distillate and residue were neutralized, washed and dried. The method of analysis of the oil for its benzene and toluene content has already been referred to.

[3] *Met. and Chem. Eng.*, 13, 682, 1915.

Analytical Data

	Anhydrous $AlCl_3$	Generated $AlCl_3$	Anhydrous[4] $AlCl_3$ on Pure Xylenes	Temperature[5] and Pressure 150 lbs. on Solvent Naphtha 750°	800°C
Recovered oil	0.870	0.872	0.871	0.940	0.989
Per cent of recovered oil 78.1		82.3	97.6	51.6	37.3
Per cent benzene in recovered oil. 1.9		1.5	5.8	19.1	42.5
Per cent toluene in recovered oil.17.9		17.6	19.5	39.9	17.3
Per cent of benzene basis of original oil 1.5		1.9	5.6	9.8	15.9
Per cent of toluene basis of original oil 13.9		14.5	19.0	20.6	6.5

The percentage yields of benzene and toluene by the two methods of using aluminium chloride are not markedly different so as to state definitely any advantage of one over the other as to yields. The percentage yield of toluene is approximately 25 per cent less when using solvent naphtha in comparison to pure xylenes. As has been shown in a previous communication[6] this would indicate less susceptibility of benzene and toluene formation under the conditions of the experiment from higher derivatives of benzene than xylenes. A comparison of the data of aluminium chloride treatment of solvent naphtha with thermal and pressure decomposition indicates that the cracking of solvent naphtha under temperature and pressure yields greater percentages of benzene and toluene as shown in above table.

Summary

1. From the results of a research on pure aromatic compounds with aluminium chloride, a commercial oil, solvent naphtha, was subjected to the same treatment with a view to obtaining benzene and toluene.

2. Two methods of experimentation were used and compared:

(a) Anhydrous aluminium chloride.

(b) Generating aluminium chloride in the body of the oil by the action of hydrogen chloride on aluminium in the presence of a catalyst.

3. A table of comparison is given involving the yields of benzene and toluene from the following methods:

(a) Action of aluminium chloride on pure xylenes.

(b) Action of aluminium chloride on commercial solvent naphtha.

(c) Cracking solvent naphtha under temperature and pressure.

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New York City.

Memorial to Joseph Priestley.—A plan for a suitable memorial to Joseph Priestley has been adopted by a committee of the American Chemical Society, which involves subscriptions to a fund of at least $2,000 to provide, first, for a bust portrait of Joseph Priestley to be deposited as a loan in the National Museum in Washington; and, second, for the award of a gold medal at intervals for superior achievement in chemical research, the recipient to deliver an address before the general meeting of the society.

[4] Moore and Egloff, Met. and Chem. Eng., 1917.
[5] Egloff and Moore, Jour. Ind. Eng. Chem., 9, 40, 1917.
[6] Ibid.

Some Applications of Magnetic Analysis to the Study of Steel Products*

By Charles W. Burrows

Introduction

The possibility of making use of magnetic determinations for estimating the mechanical properties of steel has long been before our minds, a great deal of experimental work has been carried out, and many questions have been answered. The fundamental principle that there is an exact correspondence between magnetic and mechanical properties has been established beyond doubt. Considerable headway has been made in the practical application of this principle. At the present time laboratory tests are being made upon tools, cutlery, springs, ball bearings, cables, rails and a few other articles. Not only are the laboratory methods capable of being expanded into practical shop or commercial tests, but the actual development along certain lines is in progress.

Definition of Magnetic Analysis

The science of magnetic analysis consists of the systematic correlation of the magnetic and other properties of materials and of the application of the laws and principles which underlie the interrelations of such properties, particularly the interrelations of the magnetic and mechanical properties of steel. It is based upon the fundamental fact of observation "that there is one, and only one, set of mechanical characteristics corresponding to a given set of magnetic characteristics, and conversely there is one, and only one, set of magnetic characteristics corresponding to a given set of mechanical characteristics."[1]

The art of magnetic analysis consists in the determination of the magnetic characteristics, or better, a small number of the magnetic characteristics, and from these observations making estimations of the mechanical properties.

Criteria of Mechanical Properties

The nature of a piece of steel may be studied by observing its behavior under the action of certain mechanical forces. The usual mechanical tests result in the destruction of the specimen so that it is not feasible to give such a test to the identical material to be used in a given structure. Even such superficial and intensely localized tests as the Brinell ball hardness test and the scleroscope test require the finishing of the surface tested, and after their application leave the surface in a modified condition.

Another very common way of examining steel is to determine its chemical constituents. The chemical analysis is extremely valuable and is usually considered as being the most valuable criterion of the mechanical possibilities of the steel. This test also must be made on a part of the material which does not enter into the final structure. The assumption must be made that the sample analyzed is substantially of the same composition as material to be used in the construction. The chemical analysis, however, is entirely inadequate to tell what condition the steel may have been left in as a result of its previous thermal and mechanical treatment.

In order to determine whether the steel has had proper heat treatment for a given purpose it is customary to examine the structure of the steel under the microscope, after the surface to be examined is carefully polished and etched by some suitable means. However, the microscopic analysis becomes difficult in the fine-grained steels. Here the structures of steels of slightly different heat treatment are so nearly alike that it is possible to make only a rough estimation of the heat treatment from the microscopic observations.

The mechanical, chemical and microscopic analyses of steel form the basis for the customary specifications and testing. They are, however, open to one or more of the following objections:

1. The test is vicarious. The actual material which is to be used in practice is not itself tested. Usually a certain percentage of the gross amount of material is set aside for test and the remainder is used in construction. This assumes either that the material is all homogeneous or that if non-uniform the test sample is a true representative of the entire lot. It is only by extreme care that either of these assumptions is even approximately met.

2. The test is destructive. In the tension test the specimen is usually broken. The chemical examination changes the nature of the material so that it no longer has the properties of the original. Hardness tests mar the surface to greater or less degree. This destructive nature of a test renders the piece tested unserviceable, no matter how excellent it might have been before the test.

3. The test is local. Chemical analysis may be made upon a drilling, which constitutes only 1 per cent of the sample submitted for test, which sample itself might be considered as representative of one hundred times its own magnitude. A hardness test involves still less material and even this small amount lies within a short distance of the outer surface of the test specimen. The limit of minuteness, however, is attained by the microscopic sample. The usual micrograph represents an area of less than one millimeter in diameter and is quite superficial.

4. The test may be qualitative. Some of these tests are valuable only when compared with similar tests on other material which may be considered as reference material.

Determining Factors in the Mechanical Properties of Steel

It is well known that two pieces of steel which differ in any one of a number of particulars show correspondingly different mechanical properties. It is well supported by experimental evidence, but not so generally known, that two pieces of steel which differ in certain particulars, likewise show corresponding magnetic differences. It is not feasible to go into great detail on this point at this time.[2] For the purposes of the present paper it is sufficient to give a few rather well-known examples of this correlation.

The changes that are brought about by adding certain chemical constituents to steel are well known. In

*A paper, with certain omissions, presented at the Atlantic City meeting of the American Society for Testing Materials, June, 1917.

[1]Burrows, "Correlation of the Magnetic and Mechanical Properties of Steel," *Bulletin*, Bureau of Standards, Vol. 13, p. 207 (*Scientific Paper No.* 272).

[2]In a scientific paper soon to be published in the *Bulletin* of the Bureau of Standards will be given many details on the correlation of the magnetic and mechanical properties of steel. This article will contain a rather comprehensive bibliography.

many cases the corresponding magnetic properties have been studied. With increasing carbon content in a hypo-eutectoid steel there is an increase in hardness and tensile strength and a decrease in toughness. Magnetically an increase in carbon content is accompanied by an increase in coercive force and hysteresis, and a decrease in permeability. Many other cases might be cited.

Mechanical operations also bring about corresponding changes in both the mechanical and the magnetic properties of steel. The cold drawing of a carbon steel increases its tensile strength and simultaneously increases its coercive force and hysteresis. Cold drawing also decreases the magnetic permeability.

The influence of heat treatment upon the properties of steel is fairly well known. A 1 per cent carbon steel quenched in water from a temperature above its critical point has a greater tensile strength than the same material in the annealed condition. Its hardness is also increased while its toughness is greatly decreased. Magnetically, changes of equal magnitude also occur on quenching. The quenched steel has a greater coercive force, a greater hysteresis, and a lower permeability.

In a specific case a 1 per cent carbon steel in the quenched and the annealed conditions had Brinell hardness numerals, in terms of kilograms per 0.1 mm. indention of 4390 and 800 respectively. The corresponding values of the coercive forces for a magnetizing force of 150 gausses were 33 and 12.

Steel changes with lapse of time. The course of this change is not so well known as some of the above changes. However, both mechanical and magnetic changes occur. Glass-hard steel softens with age. The same steel shows a decrease in coercive force.

The mechanical properties of a bar of steel may differ from point to point if the bar has not received the same treatment throughout. For instance, if a uniform bar is given a slight bend and again straightened it will show a slight change in its mechanical properties. There will be an increase in both hardness and tensile strength. The same bar will show a corresponding decrease in permeability in the same region.

Even during the operation of stressing a bar we feel sure that changes in the mechanical nature are occurring. Less is known about this phase of the problem than the preceding. However, we do know that small alternating stresses, even though well within the elastic limit, leave the material mechanically fatigued and if the stresses are repeated often enough rupture occurs. While it is difficult to study the changes in mechanical properties after repeated or alternating stresses, the magnetic problem is quite simple and has been investigated to some extent.

PRACTICAL APPLICATIONS OF MAGNETIC ANALYSIS

Magnetic analysis may be applied to determine the nature of the steel as a raw material, as a finished product, or even after it has been subjected to service conditions.

RAW MATERIAL

It is obvious that one cannot get a good product from inferior materials. Consequently it is desirable to know the nature of the raw stock that enters into the construction of the finished product.

Raw material must be uniform in quality. The proper mechanical and thermal treatment must be determined for each steel that is used. It very frequently happens that two steels of quite different composition may give equally good performance for a particular service provided each steel is given the appropriate heat treatment. In general the heat treatments required for the two steels will be different. It is desirable, therefore, that all the different bars of a given lot of material shall be of the same quality as the material for which the proper heat treatment was determined. Such assurance requires the examination of every individual bar of steel.

The requirement that all bars shall be alike in properties, implies that each bar shall have the proper composition, shall be properly forged, rolled or drawn, as the case may be, and shall be free from local imperfections such as blowholes, segregation, etc.

Occasionally a lot of steel of the wrong composition is supplied through error; or, by some chance, a single bar of different composition may get mixed up with the general stock. If not detected such a bar may cause much loss or annoyance. Very frequently a steel, especially among the alloy steels, may have the proper chemical composition but with the elements not in the proper state of solution.

Another defect that sometimes is found in cold-drawn material is the tearing apart of some of the crystals beneath the outer surface.

Many of these defects would pass unnoticed in the usual examinations by the chemist, microscopist, or mechanical tester. In such cases as the above a magnetic examination may be expected to be of service.

FINISHED STEEL PRODUCTS

The individual test not only permits the elimination of defective pieces but also permits the grading of a product which, while satisfactory in general, is not all of the same degree of perfection. This process of grading will enable the manufacturer to offer a uniformity of product hitherto unknown and permit him to guarantee such uniformity with surety. It is true that certain tools will have to be sold as seconds at a reduced price. On the other hand there will be a new class of exceptional quality which will bring a correspondingly higher price.

The individual test will permit improvement in design. At present we insist upon factors of safety so large that there would be a reasonable factor of safety even though there were a considerable amount of defective material. For example, a cast-iron structure might have a factor of safety of ten while a similar structure of steel would be safe with a factor of four or five.

Frequently it is desirable to make exhaustive tests upon a few pieces. Such cases arise where one or more samples are submitted in competition with other material. I recently witnessed a test on the results of which an order of $200,000 was to be based. Five pieces worth about $2.00 each were submitted by each competitor. The properties of each sample depended upon proper composition and proper heat treatment. Even though the composition were correct a slight error in the heat treatment would place the material at a disadvantage. By a suitable magnetic test the manufacturer could have assured himself that his samples were representative of his best product.

I have made laboratory tests on a number of com-

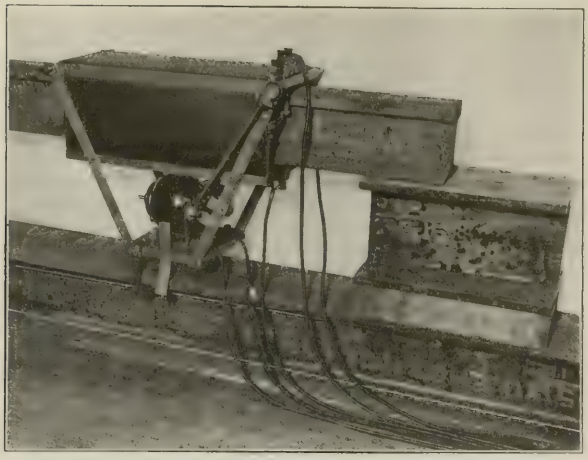

FIG. 1—SOLENOID FOR TESTING MAGNETIC LEAKAGE

mercial articles with considerable success. Experimental evidence already at hand shows that it is feasible to apply individual magnetic tests to many forms of tools, cutlery and springs. These tests are of such a nature that they may be carried out on a commercial scale. Rings and balls for ball bearings are now being tried out by this method with every promise of success. Steel rails, in spite of their size, lend themselves very readily to this method of examination.

Service Effects

Since the magnetic and mechanical properties of steel suffer changes with the lapse of time and under ordinary service conditions, the magnetic method offers a very promising means of examining, without destruction, the changes that develop during the life history of a structure. Some of the things to be looked for are the ordinary results of wear and tear. A good example of this is the mine or elevator cable. Such cables grow old and lose their usefulness or even become a source of danger due to the wearing away of the material, the breaking of strands, excessive strains, the development of a crystalline structure, etc. The causes of deterioration of a cable are so numerous and the possibility of disaster frequently so great that it is customary to replace an old cable by a new one while several years of usefulness remain in the cable. A proper magnetic test would keep the cable under surveillance at all times and make an autographic record.

A structure may fail by the development of flaws. For instance, a steel rail may render apparently satisfactory service for several years and finally develop a transverse fissure which results in a dangerous accident. Periodic examinations of rails which are under suspicion because of excessive duty or other causes may be made and we may thus detect the presence of such a flaw in an early stage of its development.

Another field which has not as yet been tried but for which the possibility has already been established is in the study of the state of stress of a given structural member. For instance, it may be desired to determine whether a given member in a bridge undergoes tension or compression during the passage of a train. The fact that steel suffers certain changes in its magnetic properties when put under tension and certain other changes when put under compression renders such a determination possible.

Routine Tests

The apparatus required and the procedure of testing depends to a great extent upon the nature and size of the material tested as well as upon the characteristic flaws to be expected. Apparatus for examining safety-razor blades is necessarily quite different, notably in size, from apparatus for the testing of steel rails. In the case of a lathe tool in which only the nose is hardened the examination differs from that of a locomotive driving rod which is more nearly uniform throughout.

Rails

If the testing of rails is to give a certainty of the quality of the material, it is necessary to test not only each rail but every element of the length of each rail. This may be accomplished by a double magnetic test. One part of the magnetic test will determine whether there are non-uniformities along the length of the rail. Since this test is based upon a determination of magnetic leakage it is referred to as the "leakage" test. The leakage test determines the homogeneity of the rail. Inhomogeneities, while they may not be due to dangerous imperfections, always cast suspicion upon the rail. Inhomogeneous rails should not be used in places where the highest degree of perfection is required. For instance, inhomogeneous rails should not be used on bridges, in tunnels, or where the traffic is heavy. Homogeneity in itself is not evidence of perfection. A rail may be quite uniform along its length and yet be an unsafe rail. Its dangerous nature may be due to improper chemical composition or to errors in the process of manufacture such as improper finishing temperatures or excessive cooling rates. To determine whether or not such defects exist requires a determination of one or more magnetic constants. These measurements may be made in some form of permeameter and in conformity with the nomenclature for similar tests on small specimens, we call this part of the magnetic examination the "induction" test.

Fig. 1 shows the general appearance of the leakage apparatus for rails. A magnetizing solenoid is moved

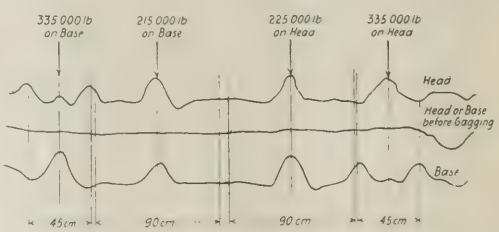

FIG. 2—LEAKAGE CURVES OF A RAIL BEFORE AND AFTER GAGGING

Vertical Arrows Indicate Position of Application of the Gag. Horizontal Arrows Indicate the Distance Between the Supports.

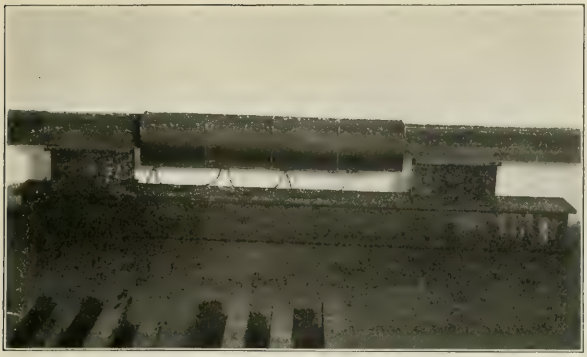

FIG. 3—SOLENOID FOR INDUCTION TEST

along the length of the rail. Any non-uniformity along the rail will cause a variation in magnetic leakage. This variation in leakage develops a small electromotive force which is approximately proportional to the degree and

It is one of a set of rails which was expressly prepared for this investigation. The rails as they left the hot bed were practically straight and therefore did not need to go through the gag press.

The middle record shows the normal record of a rail free from inhomogeneities. The irregularity in the curve at the right-hand end is due to the starting of the apparatus and therefore has no significance. From these curves several observations were made.

1. The rail before gagging shows a magnetic-leakage curve which is substantially a straight line.

2. Pressure applied locally so as to deform the metal produces a magnetic inhomogeneity at the point where the pressure is applied. This is true whether the pressure is applied on the head or on the base.

3. The extent of this local inhomogeneity depends upon the distance between supports. If the supports are far apart the strain seems to extend over the entire cross-section and seems to be greater on the side

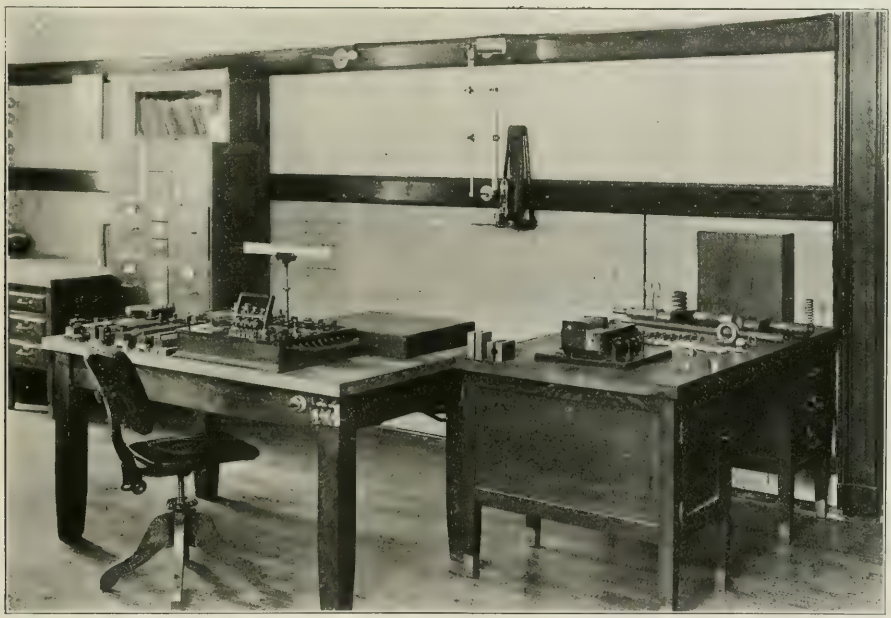

FIG. 4—MAGNETIC TESTING EQUIPMENT FOR SMALL OBJECTS

sharpness of the non-uniformity. A special recording voltmeter, not shown on the photograph, makes a photographic record of the magnetic inhomogeneities. This examination of a rail can be made in about one minute and excessive demands for skill and training are not made upon the operator.

Fig. 2 shows a set of magnetic-leakage records of a 105-lb. rail before and after gagging. This rail has the following chemical composition:

Carbon	0.68%
Manganese	0.98
Phosphorus	0.025
Sulfur	0.031
Silicon	0.144

of the rail opposite the point of application. If the supports are close together the strains are localized on the side on which the pressure is applied.

4. The strains set up by the supports depend upon the distance apart of the supports. If the supports are 90 cm. apart the magnetic effect of the supports is insignificant. If they are only 45 cm. apart this effect is considerable. In fact, the side of the rail on which the supports lie shows a magnetic inhomogeneity at each support which is greater than the corresponding inhomogeneity opposite the gag.

5. Other observations on other rails show that the

degree of magnetic inhomogeneity increases with the load applied by the gag.

6. Furthermore it is worthy of note that another rail from the same ingot which had been annealed showed a much less effect for the same gagging stress.

This ability of the magnetic leakage test to indicate the effect of gagging is of importance in view of the fact that many people consider that excessive gagging produces minute failures in the rail which are in effect potential transverse fissures.

The induction test is fairly simple. Fig. 3 shows the test rail and magnetizing solenoids in position. The accessory apparatus, which is similar to that required in induction measurements of small rods, is not shown. The most useful magnetic quantity is probably the coercive force. For the purpose of illustration we may give the coercive forces of two lots of rails of substantially the same chemical composition, made at the same mill, and differing only in their method of cooling. Four rails rolled in winter were from the first ingot which passed through the mill in starting the round for that particular date. Consequently these rails were the first upon the hot bed which was initially cold. Two other rails of substantially the same chemical composition were selected from a full hot bed and from the middle of a round rolled when the atmospheric temperature was 70 deg. Fahr. The averages of the coercive forces for a magnetizing force of 145 gausses were 10.30 gausses for the winter rails and 8.91 gausses for the summer rails. This difference of 1.39 is probably due in great part to the difference in the rate of cooling of the two sets of rails.

Tools

Fig. 4 shows a type of apparatus designed especially for the testing of drills, lathe tools, cutlery, etc. It is so arranged that the portion tested may consist of the major portion of the piece or it may be limited to the end portion.

A number of other pieces of apparatus suitable for magnetic analysis have been described more fully elsewhere.[3]

The coercive force is probably the most important test in the magnetic method, particularly in analyzing heat-treated specimens. An annealed steel may have a coercive force (the force necessary to neutralize residual magnetism) of 10, but this may be about 30 or 40 after the specimen is quenched. The coercive force will indicate differences in quenching temperatures as close as are measurable by means of the pyrometer. With rails it has not been found feasible as yet to apply the coercive force test, but dependence is placed on variations in permeability.

Commercial Magnetic Analysis

The fundamental fact that there is a definite relation between the magnetic and mechanical properties of steel is so well established that the successful application of magnetic analysis to commercial testing is assured. In any particular case the apparatus must be developed and operators trained. However, the difficulties presented are not excessive. Before shop methods of examination of any given product can be installed, a preliminary investigation must be carried out which involves five steps.

1. Magnetic data of representative material must be determined. Good, bad and indifferent materials must be examined and the data thus obtained correlated so that one may know what magnetic characteristics go with each grade of material.

2. From the mass of data thus obtained the most suitable magnetic criteria must be determined. In some cases any one of several magnetic constants may be equally satisfactory. In other cases only one specific constant may be used. Still others may require the combination of two or more magnetic constants.

3. Suitable apparatus must be designed. After the proper criteria have been determined the next step is to determine what type of apparatus is best suited for the particular material to be tested.

4. Limits of quality must be determined. Since the proper combination of speed, cost and accuracy may call for some slight deviation from the ideal theoretical considerations, the material to be tested must be examined by the final form of apparatus. From these data the final criteria of quality must be determined.

5. The final step of this preliminary investigation is the reduction of all the operations to mere routine, so that shop determinations may be made by an observer who is not necessarily an investigator.

It is not feasible to make an estimate of the cost of the testing equipment. However, it would not be excessive. The rail-testing apparatus shown could be duplicated for about $1,500.

[3]Burrows. "The Determination of the Magnetic Induction in Straight Bars." *Bulletin, Bureau of Standards*, Vol. 6, p. 31 (*Scientific Paper No.* 117).
Fahy, "A Permeameter for Magnetic-Mechanical Testing." *Electrical World*, Vol. 69, pp. 315-317 (1917).
Burrows and Fahy, "Magnetic Analysis as a Criterion of Steel and Steel Products." *Bulletin*, Bureau of Standards (a forthcoming Scientific Paper).

Explosions of Picric Acid

By T. Sington

The process of making picric acid consists broadly in mixing carbolic acid with strong sulphuric acid, diluting this sulphonate with water and then running it slowly into nitric acid. The mixture is allowed to cool, when the crude picric acid crystallizes out and it is subsequently purified by re-crystallization. After thorough washing with water to remove all traces of free nitric and sulphuric acids, the material is whirled in a centrifuge to remove the bulk of the water. It is then removed to the drying shed where it is spread on glass steam-heated beds until all moisture is removed. The acid is then transferred in large open drums to the sifting room where it is ground, passed through a revolving screen, taken to the packing room, and packed in barrels of 100 pounds each. The large crystals which fail to pass through the sieve are reground in a crushing mill.

A suitable range of buildings for the manufacture of picric acid may consist of five buildings in which the wet processes of manufacture are carried out, and of four or more others in which the acid is dried, sifted, packed, and stored. These buildings ought to be separated from one another and from the "making" rooms by intervals of about 30 feet.

Explosions in picric acid factories are of rare occurence, but the destruction is then so thorough that there is considerable difficulty in tracing the cause. In opinions based on prolonged experience and on records ex-

tending over a long period of time, it has been considered that an explosion is impossible, provided the quantity of acid in any one building is limited to a moderate amount and that the acid is absolutely free from picrates. An entire factory may thus be regarded as constituting a fire risk, rather than an explosion risk, and consequently no distances beyond those necessary to prevent the communication of fire are necessary. Brick walls have therefore been deemed sufficient to protect life, inasmuch as explosions of picric acid have always been preceded by a fire of some minutes' duration.

In the case of an explosion of picric acid two separate and distinct questions may present themselves for discussion: First, the means by which the heat necessary for ignition is produced, and, secondly, why an ignition may develop into an explosion, instead of merely resulting in a comparatively harmless combustion. One of the manufacturing processes through which the material passes is of a nature which in connection with explosives is never entirely free from risk—this is the operation of grinding the larger crystals of picric acid which have failed to pass through the screen. While picric acid is by no means easy to ignite, when it occurs ignition is most likely in the grinding mill. Thus, the operation of grinding *dry* acid occasionally gives rise to fires, which may not be followed by explosions and which are readily put out, but the possibility of explosion is always present.

That the mere process of grinding is not necessarily dangerous follows from the immunity experienced during the operation of drilling out the primer space in the solidified charge of filled shells by means of power-driven steel drills, a method which has been very generally employed without the slightest accident. It does not necessarily follow that because picric acid may be safely ground in an iron mill, that nails, stones and similar hard foreign bodies which may accidentally find their way into the powdered material, are equally harmless. In fact, many fires in picric acid factories have been traced, after careful examination, to the presence of a nail in a grinding machine. Foreign bodies may find their way into the hoppers of grinding machines in a variety of ways, but it is contrary to all experience that an explosion should follow ignition. Should this occur, it would be necessary to reconsider all previous conclusions, and even to modify to a very considerable extent the conditions of manufacture.

A picric acid explosion of exceptional violence, causing widespread destruction of property, occurred in one of the manufacturing towns of Great Britain many years ago. After an exhaustive inquiry it was established beyond all possibility of doubt that the explosion was due not to picric acid alone, but to the presence of considerable quantities of lead and strontium compounds, which under the influence of heat and in contact with the melted picric acid led to the formation of lead and strontium picrates, both of which, and more particularly the lead salt, are not only in themselves violently explosive, but are capable of detonating picric acid in contact with them. Another explosion of picric acid occurred after a fire had been raging for nearly ten minutes; it was said to have been due to the formation of picrate of lime from the mortar in the roof of one of the buildings.

Textbooks for many years stated, on the authority of chemists of the highest standing, that when suddenly heated, picric acid will explode, but the actual experience of manufacturers furnishes a very emphatic contradiction to this statement, that pure picric acid when unconfined cannot be exploded by fire. Investigation of accidents such as the above also support this view, as do also the results of experiments instituted for the special purpose of clearing up this point. A case is recorded in which an iron vessel with a very small orifice and containing 25 lb. of picric acid was placed in a reverberatory furnace, when the acid burned away without explosion.

It has been found quite possible to explode picric acid by a blow, but the blow must be one of considerable force, if the material is cold. In fact, all experience appears to prove, as surely as negative evidence can be said to prove anything, that it may be taken as a practical impossibility for picric acid to explode without giving sufficient warning by fire to enable anyone in the vicinity to escape, and moreover a fire in its initial stages can be extinguished by water without much difficulty.

In the best planned picric acid factories the quantity of material which may be present in any one compartment is limited to 2000 pounds. When this limit is adhered to, and suitable sprinklers fitted up in every building liable to contain picric acid, the danger of a fire developing into an explosion is so slight as to be negligible. The process of dry grinding is also being discontinued, and some method of dealing with large crystals in a wet state substituted.

Manchester, England.

Control of the Chamber Process of Making Sulphuric Acid

At the winter meeting of the American Institute of Chemical Engineers held in New York, February, 1917, Andrew M. Fairlie of the Tennessee Copper & Chemical Company, presented an abstract of a paper on a method of controlling the chamber process. This was published in our issue of Feb. 1, 1917, p. 149. In the *Chemical Trade Journal and Chemical Engineer* for April 7, 1917, H. E. S. Cory discusses the same problem and says that the Fairlie analytical method, while excellent, does not, perhaps, go far enough. He says the important point, *i.e.*, keeping down the nitre consumption, has engaged the attention during the last few years of many technical managers in England, and has resulted, in some of the more up-to-date works, in the application of much more scientific methods of controlling the chamber process. The well-tried methods (*a*) of observing temperature differences at different points in the system, (*b*) noting the color of the gases, and (*c*) a combination of the two, are still very useful in conjunction with other means, though it must be admitted that in many works to-day these remain the only methods utilized.

To control a plant, and to work it economically on a scientific basis, many observations and tests are necessary, and in the larger and more modern of our works, where able technical control is available, the standard has been greatly improved.

One great point, frequently formerly and indeed often to-day practically ignored, is the necessity for maintaining an adequate supply of atmospheric oxygen in the system, this being regulated in conjunction with a com-

paratively rich burner gas. A series of daily tests of the burner gases for SO_2, SO_3 and oxygen are very necessary, and often considerable fluctuations are to be found, particularly in the case of hand-worked burners, the variations being due largely to working operations from time to time. Most particularly on sets working with a low chamber space, the need for a good supply of atmospheric oxygen is very essential, since otherwise the nitre will supply the deficiency, thereby causing loss of efficiency with regard to the full utilization of the nitrous gases, and, incidentally, raising the amount to be added at the nitre ovens.

Granted an adequate supply of inlet oxygen in the burner gas (9 to 10 per cent is a good figure when using pyrites), a rich SO_2 is also to be aimed for, say 6½ to 7½ per cent, and at the same time a sufficiency of oxygen at the exit should be available. With a "tight" set this latter figure should not fall below 5 per cent, and to a large extent will regulate the composition of the burner gas itself.

The percentage of total acids and oxygen in the gases leaving the Glover tower, but before entering the first chamber, is another useful test, as it demonstrates the amount of work done by this tower and is an aid to the most effective working of the Glover. Again, the functions of the Glover tower are to be constantly observed, so that one obtains (1) perfect denitration, (2) effective gas admixture and cooling, (3) satisfactory concentration of acid, (4) efficient cooling of the acid leaving the tower, and (5) free gas passage through the tower.

The temperatures of the gases at the front and back ends of the first chamber should be noted at regular intervals, and water gages placed at various progressive points in the system serve to show the speed of the gases.

"Drips" placed at frequent intervals on all the chambers indicate the strengths of acid being made, and should be compared with the strengths of the "bottom acids" in the chambers, which comparison varies accordingly as water sprays, steam, or a combination of both be used, and depends somewhat upon the position and shape of the "drips" or drip-catchers. The "bottom acids" should be tested frequently for strength and nitrosity, and the drips occasionally and qualitatively for nitrosity.

It is highly desirable that the acid in the chambers be thoroughly circulated, so that all acid is drawn off at the front end of the leading chamber after traversing the length of all the chambers in the system and always moving in the opposite direction to the gases. By using connecting chutes alternately at opposite ends of the various chambers such a circulation can be easily carried out, and intimate contact between acid and gases is established, fresh acid surfaces continually presenting themselves. Also, the leading chamber may be used as a "denitrating" chamber, so that all acid run on from the chambers is free from nitrous compounds. This is not essential, and often not advisable where the whole or a large part of the acid make is concentrated by the Glover tower.

Any nitre contained in the "bottom acid" flowing round through this leading chamber is thus evolved, and, intermingling with fresh gases from the Glover tower, proceeds through the system again.

At times acid may be again dispatched to the last chamber after having worked round, in order to come forward again, thus maintaining an active acid circulation continually. With acid continually on the move, a nitre content to a reasonable extent frequently helps the workings, and at the same time does not damage the lead materially, as no stagnant acid is present in the system.

The acid distribution on the tower tops requires regular attention, and constant flows, particularly on the Glover tower, should be maintained. Any shortage or excess of nitrous vitriol in the circulating acids can be remedied by adjustment of the absorber tower feeds, the Glover feed never being reduced for this purpose.

As oxygen is required in the absorber towers to insure correct chemical reactions, gas tests taken between the last chamber and first absorber are most useful. The SO_2 at this point should not exceed 0.1 to 0.2 per cent, and oxygen should be 5 per cent or more, these figures applying to sets burning pyrites. However, a rise in these figures does not necessarily demonstrate a deficiency of nitre in the system, but may be due to excessive draught, which is easily righted.

Tests of the gases for total acids, *i.e.*, SO_3 and SO_2 combined, together with oxygen, may be taken occasionally at the end of each chamber, and give the operator an indication of the comparative work done by each chamber in the set.

On the absorber towers cool acid is essential, and should not exceed 90 to 100 deg. Fahr., while a minimum strength of 140 deg. Tw. is desirable. Where two absorbers or a series are working, intelligent variation and adjustment of the flows render absorption the more satisfactory.

In a well-regulated system one important aim is that of maintaining a good "nitre circulation," and to this end the acid flowing down the Glover should be frequently measured at the inlet, the nitre contents being tested simultaneously. This enables the circulation of nitre going forward from the Glover tower to be calculated in pounds of $NaNO_3$ per hour or similar convenient form. An efficient and constant nitre circulation obviously is to be aimed for, as the nitre added at the pots is thereby reduced.

Nitrosity tests of the acids leaving absorber towers should be taken thrice or more daily, and the gas "smell" test is very useful. The mode of operating the latter is as follows: The operator takes a sample of chamber gas into a small hand aspirator consisting of a rubber bulb fitted with a glass tube jet at a place not too far back in the system. A little experience enables the operator to judge how his chambers are working by differences in the "smell" of the gases, and any variation or tendency toward "souring" is checked in good time by an extra charge of nitre at the pots.

Exit tests may be done with advantage about thrice daily (express as grains SO_2 per cubic foot of gas), and a good working figure should usually not exceed 1.8 to 2 grains. As the "burner gases" at certain periods come forward into the chambers in "flushes," the following method of applying the nitre at the pots is recommended as being most economical. A minimum amount of nitre is added each hour at the pots, and this should be accurately weighed on a scale, and at intervals this amount is raised—*i.e.*, if 10 lb. per hour is being potted, perhaps every three or four hours, 20 lb. would be added in order to counteract the gas "flushes." This is undoubtedly more economical than using a regular and heavier

charge of nitre hourly, and the "smell" test is of great utility at this point. With the latter method a continuous nitre saturation is present, and this state of affairs is certainly not beneficial to the leadwork, as, on the contrary, occasional "souring" of the gases has, if anything, a good effect upon the leadwork.

A fan worked by direct-coupled motor and equipped with variable speeds should be fitted between the two absorbers, and the speed taken at regular intervals. A convenient speed for most systems is 300 to 400 r.p.m. on the fan.

A control damper fitted in the draft pipe between the last chamber and the first absorber is very suitable, and the sizes of the draft pipes should gradually diminish throughout the system. Inspection doors fitted into the chamber curtains at a height of some 3 ft. or 3 ft. 6 in. above floor level enable the operator to observe the color and movements of the gases, and are useful when acid samples are required. These doors should preferably be at an angle of 45 deg. to the lead curtain. The speed or draft is an important factor requiring frequent observation.

The control of the burners or furnaces is the most important part of the system; the control of the burners largely depends upon the analysis of the "burner gases," but painstaking examinations of the burners themselves are necessary to insure good and regular chamber workings.

By adopting such means of control as described, he states that a most economical nitre usage with a maximum make of acid should be obtainable. A maximum figure for "nitre circulation" should be decided upon for each set, as too much nitre going forward, while reducing the amount to be added at the pots (to make good chemical and mechanical losses), has a detrimental effect upon the chamber leadwork. With a reduced chamber space, however, the nitre circulation requires usually to be raised, and this undoubtedly largely contributes to the increased wear and tear. Where several sets are working together or adjacently, as in many of the larger and more modern works, these methods of control should prove very useful. Where nitric acid is used the same rules apply, though nitre may also be used for the purpose of counteracting gas "flushes" where practicable.

Synopsis of Recent Metallurgical and Chemical Literature

Japanese Industries

Current Chemical News from Japan.—In Vol. 1, No. 4, of the Chemical Technology are given several pages in English of current news from Japan, as in previous numbers. In regard to the iron and steel industry it says the production in 1914 was 303,407 tons and the consumption 1,300,000 tons. Recently a great many new companies have started up and old ones have so expanded that the production has increased enormously. The available ore is given as 50,000,000 tons of magnetite, 4,293,000 tons of hematite, 494,000 tons of brown iron ore, and 226,000 tons of sand iron. This will not last long and Japan is investigating in Manchuria, Korea and inner China for further supplies.

Gelatin and Glue.—In regard to gelatin and glue the following is of great interest:

"The importation of gelatin and glue had increased its amount to a million yen, and the quick development of our paper, spinning, cloth-finishing, sweets-making and match industry has demanded more and more importation. But the manufacturing of the gelatin and glue at home has also quickly developed. The research work has been also established at Tokyo, Osaka, Wakayama, Nara and Tokushima.

"Among the new establishments, the Takasago, Kogyo Kabushiki Kwaisha is the largest, which is going to produce 10,000 lb. gelatin and 15,000 lb. glue monthly. This amount will well fulfill the home demand. Furthermore, the Osaka-Alkali Company is going to start the manufacturing, while the Mitsubishi Company is enterprising a big firm at Kakogawa. These big firms will certainly bring a big surplus against our home trade and we must expect certain panic in a near future unless they will find a proper market."

Chemical Exhibition.—An exhibition of chemical products is being arranged and it is hoped to open same in October.

Wood Distillation.—Prof. Dr. Tamara has issued a report as follows:

Total demand of 80 per cent Ca-acetate per month is:

For glacial acetic acid	110,295	kwan.
For acetone	61,250	"
Total	171,545	"

Total production of 80 per cent Ca-acetate at home is:

The Nippon Acetic Acid Co., Shiwobara Works	13,800	kwan.
Kabafuto (Sagalin) Government Works	8,280	"
Tottori-ken, Kondo Works	3,600	"
Chichibu Distillation Works	3,200	"
Wakayama Province	20,000	"
Saëtama Province	5,000	"
Others	7,000	"
Total	60,880	"

This output is only 36 per cent of the demand, the rest, 64 per cent, being imported. On the other hand, the demand of glacial acetic acid at rubber districts of Oceania has lately enormously increased.

Crude methyl alcohol is also much required, which is converted into 99 per cent pure methyl alcohol, 95 per cent spirit, 90 per cent spirit. Among them, the pure methyl alcohol is much consumed for the manufacturing of formalin. The total demand of formalin at home is about 1,500,000 lb. annually, which corresponds to about 1,250,000 lb. 99 per cent methyl alcohol, or 3,125,000 lb. crude methyl alcohol. That is, we require about 260,000 lb. crude alcohol per month. At present crude alcohol is produced monthly as the following:

The Nippon Acetic Acid Co., Shiwobara Works	18,000	lb.
Kabafuto Government Works	15,000	"
Tottori-ken, Kondo Works	3,600	"
Chichibu Works	1,000	"
Total	37,600	lb.

This amount is only 14.5 per cent of the total demand. We want further wood tar, not only for the producing of formalin, but for the manufacturing of creosote, guiacol, guiacole carbonate, thiocole.

Refractories

Hot and Cold Sizes of Firebricks.—In the *Iron and Coal Trades Review*, June 15, 1917, the results are given of experiments by J. W. Mellor, on hot and cold sizes of typical firebricks. The article is included in a report of the Refractory Materials Committee of the Institution of Gas Engineers, made at its meeting in London June 5. The experiments were carried out at the County Pottery Laboratory, Stoke-on-Trent, and formed one of a series on refractories.

The measurements on the whole brick were made with Coppée's apparatus. Two cuts are made in the brick; each cut is intended to hold a pointed platinum wire. The two saw cuts are arranged so that the wires fit tightly. The distance apart of the tips of the wires is measured while the brick is cold (15 deg. C.) by means of a cathetometer provided with an invar scale. The brick is heated in a furnace to the desired temperature, and, by means of suitable apertures in the furnace, the distance apart of the wires is measured again. The results are indicated in Table I.

Table I

Type of Brick	Distance Between Platinum Wires. Before Firing. Cms.	Distance Between Platinum Wires. After Firing. Cms.	Percentage Expansion	Linear Co-Efficient of Thermal Expansion
Silica brick	17.95	18.05	0.56	0.0000048
Firebrick	18.78	18.87(5)	0.51	0.0000044
Firebrick	20.31	20.45	0.69	0.0000059
Firebrick	19.43	19.50	0.36	0.0000031
Firebrick	20.06	20.25	0.95	0.0000082
Silica brick	20.29	20.43	0.69	0.0000059
Firebrick	19.83	19.94	0.55	0.0000047
Firebrick	19.80	19.92	0.61	0.0000052
Firebrick	19.01	19.06	0.26	0.0000022
Firebrick	18.35	18.42	0.38	0.0000033
Firebrick	18.68	18.80	0.64	0.0000055
Firebrick	18.54(5)	18.66	0.62	0.0000053
Firebrick	18.77	18.83	0.32	0.0000028
Firebrick	18.29	18.41	0.66	0.0000057
Firebrick	18.71	18.84	0.70	0.0000060
Firebrick	19.41	19.53	0.62	0.0000053
Red silica brick	19.29	19.46	0.88	0.0000076
Silica brick	18.27	18.41	1.77	0.0000066
Silica brick	18.52	18.78	1.40	0.0000121
Silica brick	18.85	18.94	0.48	0.0000041
Firebrick	18.53	18.66	0.70	0.0000060
Firebrick	18.84	18.98	0.74	0.0000064
Firebrick	18.89	19.06	0.90	0.0000177
Firebrick	19.50	19.70	1.03	0.0000088
Firebrick	18.93	19.07	0.74	0.0000064
Magnesite brick	18.39	18.66	1.47	0.0000126

If the brick is imperfectly burned, there is superposed on the effects of thermal expansion an after-contraction or after-expansion. In consequence, in the former case the results are too small, and in the latter case too large. Still further:

(1) The brick does not contract to its original volume on cooling. The difference between the cold sizes of the brick before and after firing shows the magnitude of the after-contraction or after-expansion, when the brick was heated under conditions of the experiment.

(2) In all cases of after-contraction (or, *mutatis mutandis*, after expansion), the brick may show a smaller volume at, say, 1,180 deg. C. than it does at, say, 1,060 deg. C. This shows that the effects of thermal expansion are altogether masked by the after-contraction. Thus:

Distance of wires at	15° C.	18.72 cm.
" "	1,060° C.	18.80 cm.
" "	1,180° C.	18.75 cm.

It was only when the whole of the cold and hot measurements were under consideration and were being extended to different temperatures that the duel character of the phenomenon was discovered; and it has made the Committee suspect these and other measurements of the coefficients of thermal expansion of refractory materials at high temperatures—unless it can be demonstrated that the results are not affected by the error under consideration.

These measurements also show that the coefficient of expansion of fireclays and of silica bricks decreases with rise of temperature. Thus, in two cases:

Silica Firebricks.

	I.	II.
From 15° to 940° C.	0.0000069	0.0000081
From 15° to 1,180° C.	0.0000060	0.0000060

Silica Firebricks.

From 15° to 940° C.	0.0000051
From 15° to 1,180° C.	0.0000064

It will be observed that the coefficient of thermal expansion represents the average increase in length which a break undergoes when unit length is heated 1 deg. C.; so that a 9-in. brick with a coefficient of 0.000005 will be 9 $(1 + 0.000005 \times 1{,}200)$, or 9.054 in. long at 1200 deg. C. Otherwise expressed, a brick $2\frac{1}{2}$ in. thick when cold will be $2\frac{1}{2}$ $(1 + 0.000005 \times 1{,}200)$, or 2.515 in. thick at 1,200 deg.; or, neglecting the jointing cement, sixty-six bricks piled one on top of the other would expand 1 in. when heated to 1,200 deg.

After-Contraction or After-Expansion of Firebricks in Oxidizing and Reducing Atmospheres.—Another investigation by the same author dealt with the above subject. It is well known that ferrous iron has a far greater fluxing action than ferric iron, so that the contraction of a brick fired under reducing conditions will probably be greater than when fired under oxidizing conditions, providing no bloating occurs. Nearly all firebricks are burned under oxidizing conditions. It therefore appeared of interest to find the difference in the results obtained in the specification contraction test when conducted under oxidizing and under reducing conditions. Some measurements are given in Table II.

C signifies contraction, *E* expansion; the specimens marked with an asterisk were fired at cone "12" for two hours, and the others at cone "14." See standard specification.

These results show a general tendency for silica bricks to give a less expansion in a reducing atmosphere than in an oxidizing atmosphere; and for (fireclay) firebricks to give a greater contraction in a reducing than in an oxidizing atmosphere. This result might have been anticipated, because it is in agreement with the much greater fluxing effect of iron in a reducing than in an oxidizing atmosphere.

Table II

Type of Brick	Percentage After Expansion or Contraction (Means of Duplicates). Oxidizing Atmosphere		Reducing Atmosphere	
Silica brick, unusually fine grained..	0.44	C	0.77	C
Silica brick, high in "iron"	0.58	E	0.48	E
Firebrick	0.21	E	Nil	—
Firebrick	Nil	—	0.33	C
Firebrick	1.12	C	1.27	C
Silica brick	0.20	E	0.13	E
Silica brick	0.13	E	0.12	E

The magnitude of the fluxing effect induced by the reducing atmosphere depends upon a number of factors. For example: (1) It depends upon the strength of the reducing atmosphere; that is, on the proportion (and kind) of reducing gases in the given atmosphere; (2) it will also depend upon the rate the gases penetrate into the interior of the brick, and this in turn depends upon the character of the superficial skin and on the

porosity of the brick; and (3) on the time and temperature the brick is bathed in the reducing atmosphere. It is, therefore, difficult to get comparable results with the contraction test under reducing conditions. This agrees with some previous results obtained by determining refractory tests under reducing and oxidizing conditions.

For similar reasons, a neutral (or slightly oxidizing) atmosphere was prescribed for the refractory test, until further experiments showed how this source of variation could be eliminated. It would be unwise to prescribe a test which gives variable results. The author expects that further experiments on this subject will be ready for the next annual report; meanwhile, it is recommended that the "contraction test" be conducted like the refractory test—that is, in as nearly a neutral atmosphere as practicable.

Recent Metallurgical and Chemical Patents

Sintering

Apparatus for Roasting and Sintering Ores.—ARTHUR S. DWIGHT of New York, N. Y., has patented

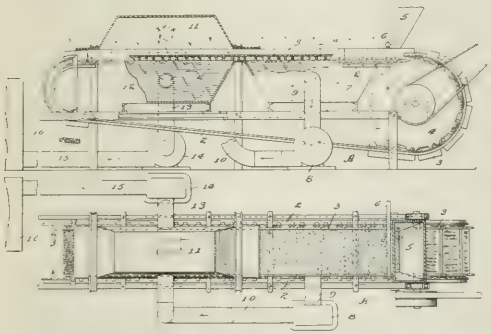

FIG. 1—DWIGHT SINTERING MACHINE

a new sintering machine which is illustrated in Fig. 1. The improvement in this machine over the Dwight-Lloyd machine consists in eliminating the waste of the fine sulphur which is found in gases coming off from some sulphide ores during the operation of the last-named machine. This sulphur is in a very finely divided state and ignites on the gases issuing into the air. It is the aim in this machine to convert the elemental sulphur escaping from such ores into sulpur dioxide, thus increasing the amount of this gas in the gases coming from the machine. This is accomplished by constructing the apparatus in such a way that the ignited sulphide ores may be repeatedly treated by the same volume of air in separate units, i. e., the air used to treat the first unit of ignited ore is passed to a second body of ore and supplying thus the oxygen required for the roasting or sintering of said second body of material. In this manner the patentee has been able to increase the sulphur dioxide content of the gases to 9 per cent, and it is his belief that the proportion of dioxide of sulphur may be increased still more. (1,215,637, Feb. 13, 1917.)

Agglomerating Flue-Dust and Fine Ores.—A patent was granted to WILHELM SCHUMACHER of Berlin, Germany, for a new method of roasting or sintering finely divided ores and flue-dust. The principle employed consists in incorporating in the form of small, permanent, ball-like or egg-shaped briquettes the finely divided particles of such fine ores whose sintering and melting points are relatively close together, then exposing such briquettes to a temperature between the sintering and melting temperatures of the ores and maintaining continual movement of the briquettes while in the sintering or roasting zone. (1,222,893, April 17, 1917.)

Nickel

Treatment of Nickel Ores.—A patent was granted to FREDERIC A. EUSTIS of Milton, Mass., for the extraction of nickel from its ores by a wet method. The ore is first subjected to heat treatment, preferably a sulphatizing roast. This is done with the intention of converting the nickel into a soluble form. If not enough sulphur is present in the ore as such, 5 to 10 per cent of its weight of sulphur-bearing material such as pyrite should be added. Roasting takes place at about 460 deg. C. and is continued for approximately 4 hours. It is also possible to moisten the ore with the least possible amount of sulphuric acid and then roast at 500 deg. C. for a considerable length of time. The roasting converts a large proportion of the nickel present into the soluble sulphate. A considerable amount of alumina is also converted into the sulphate, while a relatively small amount of the iron is converted into sulphate. The heat treatment also affects the amount of iron which will be taken into solution. Little soluble iron is formed. The roasted product is then leached with dilute sulphuric acid, or with a solvent consisting of water containing one-half of 1 per cent of sulphuric acid and 7 per cent of hydrochloric acid. The solvent should be applied hot (100 deg. C.), so as to prevent as much as possible the solution of iron salts.

The solution containing the nickel and some alumina and iron, is then preferably passed through a trommel containing pieces of limestone. The trommel is slowly rotated and the solution becomes neutralized and calcium sulphate is precipitated. After neutralization has been accomplished the solution should be drawn off and received in another receptacle containing limestone. This will primarily precipitate the alumina and near the end iron will come out. When this point is reached, the solution is again drawn off and conducted into a vessel containing soda ash or some other material forming soluble sulphate. The precipitated nickel may be sold as such or re-treated with a suitable solvent such as sulphuric acid or a solution of ammonium or potassium sulphate in sulphuric acid to form an electrolyte from which the nickel as such may then be deposited. (1,212,334, Jan. 1, 1917.)

Rare Metals

Method for Treating Vanadium-Bearing Ores.—ROYAL S. DAVIS of Newmire, Col., was granted a patent for an improved method of treating vanadium-bearing ores and particularly for the recovery of values ordinarily rejected when treating the ore preparatory to reduction. The ores are subjected to a chloridizing roast in a reverberatory furnace to convert the vanadium into a vanadate. The roasted ore is then leached and the residue left, containing recov-

erable amounts of vanadium in the form of V_2O_5, is then treated for the recovery of the vanadium content.

The gases coming from the chloridizing furnace are scrubbed and cooled by passing them in a coke tower. The water trickling over the coke collects and absorbs the SO_2 and Cl in the gases. This solution then is applied to the ore residue and it is found will convert the V_2O_3 to a soluble vanadate, which in turn is then leached. It is claimed that the unscrubbed gases may be applied directly to the moist ore, giving satisfactory recoveries. Ten to fifteen per cent greater recovery is claimed for this method over the ordinary water leaching process. (1,223,567, April 24, 1917.)

Alloys

Aluminium Alloy and in Articles Made Therefrom.—A patent under the above heading was granted to Albert W. Morris of Springfield, Mass. The invention relates to an aluminium alloy and to castings and forgings made therefrom, the object being to provide an alloy which will permit of the full chilling effect of the mold or die, will reduce the shrinkage of the castings or forgings, overcome the danger of cracking, increase the tensile strength and the elongation properties. The alloy may consist of aluminium and iron alone, or it may contain zinc, copper, nickel, cadmium, magnesium and manganese, besides the aluminium and iron. A certain proportion of iron, properly alloyed with the aluminium will, according to the inventor, produce the claimed effects. Where the alloy contains other metals, the percentage of aluminium should not be less than 70 per cent of the whole, and the percentage of the iron present should not be less than from 1 to 6 per cent. Care should be exercised to keep the silicon content as low as possible. The iron may be introduced in the form of ferro-aluminium, ferro-zinc, ferro-copper or the like, or it may be introduced in the metallic state in form of filings or chips, or it may be derived from the furnace pot or crucibe in which the aluminium is melted. The invention, it is claimed, is of especial importance in the manufacture of fuses and detonators for explosive shells as it creates a great density in the product and prevents leakage through it of the gases, which would cause premature explosion of the shell. (1,227,174, May 22, 1917.)

Gases

Electrical Treatment of Hydrocarbon Gases.—A process of treating gases, such as illuminating gas with a high-tension electric discharge, is patented by J. G. Davidson and R. W. Ford of Vancouver, B. C. By subjecting a gas or vapor containing a hydrocarbon or hydrocarbons, such as illuminating gas, or other gas produced by the destructive distillation of coal or petroleum, or other methods of manufacture or production, to the action of a high-tension electric discharge under certain conditions, a considerable change may be effected in the final product, indicating an increase in the proportion of fixed gases in the total final product and an increase in the volume of gas produced. An important object of the invention is to increase the percentage of fixed hydrocarbons in illuminating or similar gases, by breaking up condensable constituents into substances of less molecular weight and less condensability. Another object incidental to the above is to increase the volume of gas produced. (1,229,042, June 5, 1917.)

Platinum Substitute

Platinum Substitute.—Alloys of palladium, silver and cobalt are patented by Hugh S. Cooper of Cleveland, Ohio, and assigned to the Electro-Metals Products Co. of Cleveland, Ohio. One composition stated to be a successful platinum substitute for electrical purposes consists of 70 per cent silver, 25 per cent palladium, and 5 per cent cobalt. Platinum may be substituted for the palladium with good results, and nickel for the cobalt. The alloys are adapted for use in coils, magnetos and all vibrating instruments. (1,229,037, June 5, 1917.)

Iron and Steel

Low-Carbon Ferromanganese.—A method of making ferromanganese containing less than 1 per cent of carbon is patented by Ernest Humbert of Niagara Falls, N. Y. The reduction of the carbon is affected by treating commercial ferromanganese containing up to 6 per cent of carbon with manganese oxide. An electric furnace of the Heroult type is used. A specific example of the process is given as follows: "Take 2000 lb. of ferromanganese containing 6 per cent carbon. This is 120 lb. of carbon, and requires 160 lb. of oxygen. This amount of oxygen will be found in 710 lb. of manganese oxide (MnO). If the reaction were perfect there would result 2000 — 120 + 550, a total of 2430 lb. of ferromanganese containing no carbon. These calculations are for pure oxide of manganese. As commercial manganese ore is never pure MnO, the calculations must be made on the MnO content. Also a certain excess of the oxide must be used, about 10 to 20 per cent over the theoretical amount, because a certain amount of the oxide remains in the slag. The ferromanganese is introduced into the furnace either cold or molten. If cold, it is first melted in the electric furnace. The manganese oxide is then added. Probably the best voltage to use is 50 volts at each arc, but it may be varied according to the design of the furnace and other considerations. The quantity of current, amperes, should be sufficient to keep the mass at the temperatures stated. A test of the metal will show a reduction of carbon by the appearance of the fracture, being less crystalline and more like steel than in high-carbon ferromanganese. Also the specimen will be less brittle the lower the carbon.

The low-carbon ferromanganese produced by this method is stated to be of a special utility in the making of what is commercially known as manganese steel containing a comparatively high percentage of manganese, ordinarily from 10 to 15 per cent. (1,228,925, June 5, 1917.)

Welding Scrap Nickel Anodes

The practice of utilizing every pound of nickel anodes for service by welding the scraps together is effecting a considerable saving in many plating departments and establishments, and is of special importance at the present time. An account of experiments made by the Prest-O-Lite Co. of Indianapolis, Ind., was given in our issue of July, 1915, page 453.

Until recent years, many firms sold their anodes as scrap for want of a thoroughly satisfactory method

of utilizing them. This was always a source of considerable loss to platers, for the scraps often represent a considerable portion of the original anodes and their junk value is less than one-half their original cost. By welding the scraps together, by the oxy-acetylene welding process, every pound of the costly metal is utilized for plating purposes.

The practice of welding scrap anodes is usually as follows: The worn anodes, as they are withdrawn from the tanks, are turned over to some workman who handles the welding. A scrap of suitable size and shape is selected as a "hanger" and other scraps are "tacked" to it by welding until the desired size and weight are secured. The "tacking" consists of melting the scraps, at the point of welding, by the heat of the oxy-acetylene flame, allowing them to run together or "fuse" into one piece. The "tacking" of a joint requires but a moment as the temperature of the oxy-acetylene flame, which is approximately 6300 deg. Fahr., causes the metal to "fuse" quickly.

No flux is used—the metal simply runs together and where necessary another piece of scrap nickel is used as a filling rod.

The oxy-acetylene flame is also used to remove the brass hooks from the scraps, the solder melting rapidly, leaving the pure anode to be welded.

Several other methods of utilizing scrap anodes have been tried in the past, but with uncertain results. The method of fastening them together by means of rivets and similar methods are seldom thoroughly dependable because of uncertain conductivity. It is impracticable for anyone but the manufacturer to remelt and repour anodes, because in so doing the composition is changed. An advantage claimed for welding the scraps together is that the original composition is not changed and the fused joints insure conductivity equal to that of new anodes.

Another advantage claimed is the fact that no skill or experience in the art of welding is required to weld up scrap nickel anodes. Any workman of average intelligence can do the work without previous knowledge of the process.

The accompanying illustration shows the welding of scrap anodes by the Prest-O-Lite process of oxy-acetylene welding. Welded anodes are seen in the foreground.

OPERATOR WELDING SCRAP NICKEL ANODES

American Sulphur Company Rapidly Expanding

The accompanying illustrations, Figs. 1, 2 and 3, show the pumps, foundations and buildings of the Freeport Sulphur Mines located at Brazoria County, Texas, at the mouth of the Brazos River on the Gulf of Mexico, and are the property of the Freeport Sulphur Company. The discovery of the sulphur deposit was accidentally made while prospecting for oil, and its location is believed to be unique as being the only mines situated at tide water and having a deep-water harbor immediately adjacent from which shipments by vessel are made.

It may be stated that the great sulphur deposit underlies "Bryan Heights," one of the domes which dot the coastal plain. It has an area of about 500 acres, and its crest is but 28 ft. above mean low tide. The suplhur-bearing horizon lies many hundred feet under the surface, surmounted by a limestone cap, the sulphur occurring in pockets and veins in a porous gypsum formation heavily loaded with water, as it is below sea-level. To recover the sulphur, millions of gallons of boiling water are forced into the formation under heavy pressure, searching out the sulphur and freeing it from the rock which contains it. In its melted state it is pumped by compressed air to the surface, where it is forced through piping to immense storage bins, where it congeals and builds up huge blocks of solid sulphur 99½ per cent pure.

It is of interest to note that the largest oil-burning steam boiler plant in this country has been established at the mines to recover the sulphur. The experimental plant, known as plant No. 1, was built in 1912, and has a capacity of 3000 boiler-horsepower. Plant No. 2 was built adjoining plant No. 1 in 1914, and has a capacity of 4000 boiler-horsepower. Plant No. 3, finished this year, and plant No. 4, now under construction, are situated on the other side of the mound and have a capacity of 8400 horsepower each, making

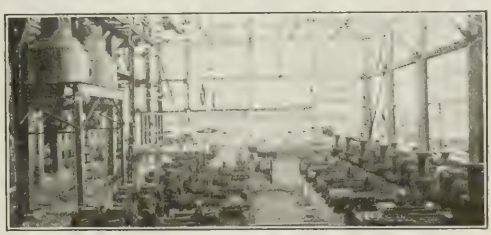

FIG. 1—FREEPORT SULPHUR COMPANY, FREEPORT, TEX. PUMPS IN PLANT NO. 3

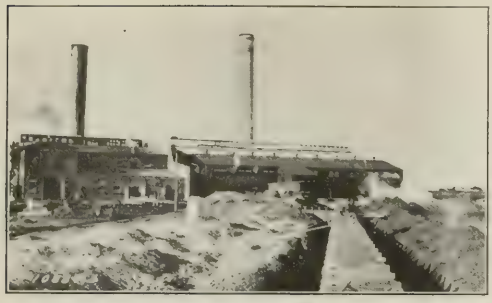

FIG. 2—FREEPORT SULPHUR COMPANY, FREEPORT, TEX. PLANT NO. 1 AT LEFT, NO. 2 AT RIGHT

a total installation of 23,800 horsepower. The buildings are constructed of steel and corrugated iron on concrete foundations. Fuel oil for boiler purposes requires continual tank steamer service from the Mexican oil fields, and the Freeport Sulphur interests own and operate their own tank line.

It may be mentioned that the boiler water supply is obtained from a series of wells, pumped by air compressors, and is stored in two reservoirs. The mine water supply is obtained from the river through a canal 3½ miles long, and is pumped into two separate reservoirs. Both mine and boiler water are treated with calcium hydrate to remove scale-producing salts before going to the reservoirs, where the precipitation takes place. The precipitated sludge is periodically pumped out of the reservoirs by a hydraulic suction dredge. A day's water supply is pumped and treated in 8 hours, and 7000 lb. of calcium hydrate are daily used in the process.

Electric power is used to great extent, the pumps being electrically driven. The power equipment consists of two 250-kw., 2200-volt generators, and one 500-kva., 22-volt generator. This power plant transmits current to the town of Freeport for lighting and power as well as to the pumping stations. A 4-ton ice-making plant and water-purification plant furnish the works with all ice and drinking water required. All excess steam about the plant is used for heating water. After scale-producing salts have been removed from the boiler water there still remain salts which cannot be removed by chemical treatment and cause foaming and priming in the boilers.

It is claimed that the concentration in the boilers is kept within safe limits by continuously blowing them off, and special arrangements are made for recovering the heat from the blow-off water. At the water's edge a large timber-loading dock was built. Sulphur dynamited at the storage bins is loaded by means of two locomotive cranes with clamshell buckets into 50-ton cars and carried to the dock.

The storage tracks for full and empty cars at the dock are so graded that cars are delivered by gravity to the foot of the incline leading to the elevated dock structure and empties returning from the dock are delivered by gravity to the empty storage tracks, thus doing away with the service of a switching engine. The loaded cars are hauled one at a time by a barney car operated by a 200-hp. winding engine up the 15 per cent incline to the top of the elevated dock where they discharge the sulphur into chutes leading directly to the hold of the vessel. The empties are returned three or four at a time down the incline by the same means. A 3000-ton ship can be loaded between tides.

FIG. 3—FREEPORT SULPHUR COMPANY, FREEPORT, TEX. PLANT NO. 3 IN BACKGROUND, FOUNDATIONS FOR PLANT NO. 4 IN FOREGROUND

Operation of a Temperature Regulator

The enormous pressure developed when oil is heated in a filled metal cylinder is utilized in the Sarco temperature regulator, made by The Sarco Company, Inc., of New York City. The regulator operates gas, steam or water valves and can be used for tank or atmospheric control. Referring to the illustration, Fig. 1, the oil cylinder communicates through a pipe with another cylinder in which there is a piston, the entire system being completely oil filled. The piston in the piston cylinder actuates a valve. If the oil cylinder is immersed in a tank containing the fluid, temperature of which is to be regulated and that tank is heated, say by a gas flame, the supply of gas to which is regulated by the supply valve, the mode of operation is obvious. When the temperature of the tank liquid rises, heating the oil in the oil cylinder, the expanding oil pushes the piston outward in its cylinder and closes down the supply valve, thus reducing the gas flame. If on the other hand the tank temperature falls, the oil in the cylinder cools and contracts, thus allowing the piston in the piston cylinder to go back under the influence of a spring (not shown) opening the supply valve and thus turning the gas flame higher.

Were the piston in the piston cylinder of the conventional type, trouble would ensue because, obviously, successful operation requires that the oil system be absolutely tight, the escape of even a minute quantity of oil altering the whole setting. In other words, it is imperative that the piston packing be leak-proof, capable of withstanding the enormous pres-

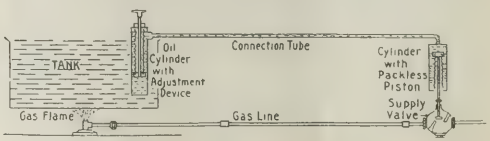

FIG. 1—DIAGRAM OF REGULATOR AND CONNECTIONS

sures which are involved, and at the same time frictionless. The Sarco Company has developed a spirally corrugated tube, a section of the same being hermetically attached to the outer surface of the piston at one end, and to the inner skirt of the oil cylinder at the other end, as shown. This tube will withstand pressures in excess of 3000 lb. per square inch.

While the regulating system as so far described is complete and would be commercially operative, it is naturally desirable to add some means of adjusting the temperature setting. This is accomplished by having the connection tube issue from the side of the oil cylinder instead of from the top, and then inserting from above a piston which can be adjusted up or down by a regulating screw. When adjusted downward the temperature in the tank need evidently rise less before pressure is transmitted through the connection tube to close the supply valve, and if adjusted upward the temperature must rise higher before closing will take place.

A relief element is also supplied which will yield if the pressure after the control valve has been closed should for some special reason continue to rise and exceed even the high limit of strength of the tubing. The element is a special heavy spring interposed between the manually adjustable head of the rod in the oil cylinder and the piston which the rod pushes. The spring strength is such that it will yield when pressure is too high, restoring itself to normal length when normal conditions are resumed.

An Automatic Starter for Induction Motors

In a paper recently presented at Chicago before the Association of Iron & Steel Electrical Engineers, H. F. STRATTON, vice-president and chief engineer of The Electric Controller & Manufacturing Company, Cleveland, Ohio, described an automatic starter for squirrel cage alternating-current motors. He said the need of an alternating current automatic motor starter has been clearly shown by the constant demand for something which would do for the squirrel cage motor, what the automatic starter has done for the direct current motor.

Unfortunately, the same advance has not been made in the development of the automatic starter for alternating current motors, although there are more squirrel cage motors in use than any other type of electric motor from the standpoint of numbers and total horsepower.

Speaking generally, the E. C. & M. automatic compensator starts a squirrel cage motor in the usual way, in that the motor initially receives a reduced voltage through a transformer, and after the attainment of considerable speed, the reduced voltage is withdrawn and line voltage is quickly applied to the motor. Beyond this similarity, the compensator differs radically from any existing equipment.

Fig. 1 shows the starter with cover removed. The case is full of oil and the machine itself is built in one unit and fits simply in the case.

Fig. 2 is a three-quarterd side elevation, showing the compensator in the "starting" position and Fig. 3 shows it in the off position. T_1 and T_2 are the two coils of an open-delta transformer. The voltage taps from this transformer are brought up to a terminal board which is above the oil level. Any one transformer is built up entirely of laminations of the same shape and size, so designed that they can be assembled with all joints lapped. The assembled transformer laminations are clamped between the transformer end frames, marked EF_1 and EF_2.

M is a U-shaped member built up of high-silicon steel laminations which are electrically welded together along six different places on the exterior of the magnetic circuit. Steel plates are also electrically welded to this frame, and are tapped so that, by means of bolts, the magnet may be attached to the main frame of the compensator. Three small horizontal slots and one larger horizontal slot are cut into the upper pole face. The three small horizontal slots are oil canals to permit the armature to open rapidly when the magnet is de-energized. In the large slot is held a copper bar, each end of which is riveted to a brass casting extending upward and supported by a slanting piece of molded asbestos board marked AB. This asbestos board also supports on its under side a cast grid resistance unit. The induced current flows through the copper bar, the two brass castings and the resistance unit when the magnet is in operation, and as this electrical circuit encloses only a portion of the upper pole, there are set up magnetic forces in different sections of the upper pole of the magnet which are out of phase with each other, and which prevent the magnet from chattering.

FIG. 1—COMPENSATOR WITH TOP OF CASE REMOVED

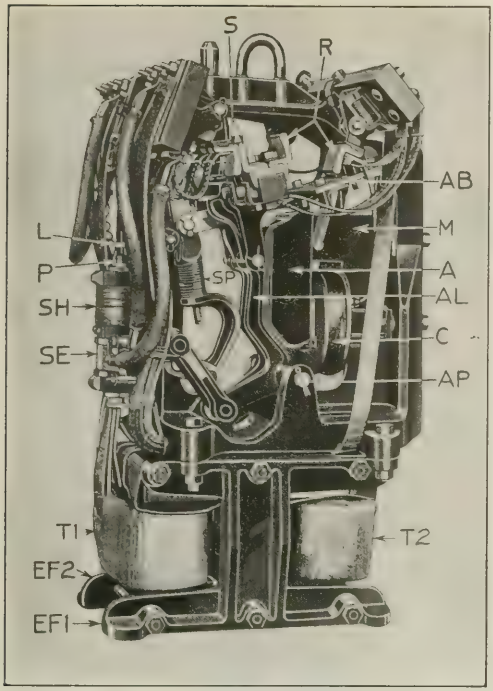

FIG. 2—COMPENSATOR IN STARTING POSITION

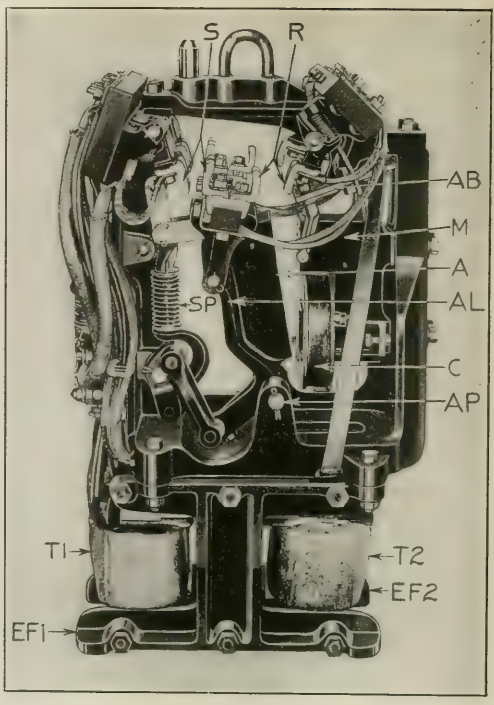

FIG. 3—COMPENSATOR IN OFF POSITION

The operating coil *C* encloses the lower pole of the magnet, and the wire is wound on a brass spool with supporting lugs.

At the face of the lower pole a strip of non-magnetic metal is loosely supported, forming a gap in the magnetic circuit when the armature is closed. This material is not only non-magnetic, but it also has high ohmic resistance, to reduce the heating and the useless wattage which would be caused by eddy currents which are set up.

The armature, *A*, is also built up of electrically welded steel laminations, and it is welded to the cast steel armature lever, *AL*, which is pivoted to the frame by means of the phosphor bronze rod, *AP*.

It will be noticed that there is only one operating magnet for the entire mechanism, and that this one magnet, when energized, must establish the starting connections and, after a delay, allow the starting connections to be broken and the running connections to be established. This is accomplished by an interesting mechanical movement. With the armature in its closed position, as shown in Fig. 2 it will be noticed that the contacts, *S*, are in engagement, establishing the starting connections to the motor, and that the spring, *SP*, has been compressed. The compensator remains in this starting position until it is released by the action of the transition relay. Its plunger, *P*, lifts when the starting current in the motor drops to a value which is suitable for a change in motor connections from the transformer to the line. When the transition relay operates, it raises the pivoted latch lever, *L*. This movement of the latch lever permits the compressions spring, *SP*, to act on a toggle joint, quickly throwing the movable contacts from the starting side to the running side; in other words, the motor is disconnected from the transformer and is connected to the line. When it is desired to stop the motor, with the compensator in either the starting or running position, the operating magnet is de-energized and all parts fall into the "off" position, shown in Fig. 3.

The following is a brief summary of the sequence of operations:

First, the operating magnet is excited, closing the armature, compressing a spring and connecting the motor to the source of supply through the transformer; second, after the motor has attained a suitable speed, the transition relay operates a latch, permitting the compression spring to disconnect the motor from the transformer and the transformer from the line and to connect the motor to the line; third, when the operating magnet is de-energized, the armature falls open and the motor is disconnected from the supply lines.

The transition relay shown in Fig. 2 includes a top shunt coil, *SH*, tending to lift the plunger, *P*, when energized, and a bottom coil, *SE*, in series with the motor in starting, tending to hold the plunger down when energized.

The transition relay is self-adjusting, in that the selection of the voltage taps also selects the right adjustment for the operation of the transition relay. In other words, the higher the votlage tap selected, the higher will be the value of motor-starting current at which the relay functions.

Personal

Mr. **James J. Bajda,** formerly chief dye chemist and chemical engineer for B. Heller & Co., has associated himself with the Block Chemical Laboratories, where he will have charge of their many dye plants now under construction.

Mr. **R. A. Bull,** formerly of the Chicago Steel Foundry, is now vice-president and general manager of the Duquesne Steel Foundry Co. His headquarters are in the Arrott Building, Pittsburgh, Pa.

Prof. **William Campbell** of Columbia University, New York, is now serving as consulting metallographist at the New York navy yard.

Mr. **J. D. Collier,** director of L. J. Healing & Co., Ltd., Tokyo, engineers and contractors, is visiting America on a short business trip and expects to arrive in New York the first week in August. His address is c/o W. J. Sparks, Inc., 17 Battery Place, New York.

Prof. **C. E. Davis** has resigned as professor of chemistry at the Utah Agricultural College at Logan, and accepted a position as research chemist for the National Biscuit Co., with headquarters in the Havemeyer Laboratory, Columbia University.

Mr. **H. M. Deavitt,** consulting chemist, with offices and laboratories in the Rookery, Chicago, Ill., has been elected a director of the Mechanics and Traders' State bank.

Mr. **George B. Hogaboom,** formerly plater with the International Silver Co., Meriden, Conn., has joined the research forces of the Scovill Manufacturing Co., Waterbury, Conn.

Messrs. **Henry D. Lindsley** and **Thomas C. Desmond** announce the organization of their business as investment bankers and engineers under the name of Lindsley, Desmond & Co., Inc., 31 Nassau Street, New York City.

Mr. **R. M. Klein** has been appointed sales manager of the International Oxygen Co., with headquarters at the company's main office, 115 Broadway, New York. Mr. Klein was formerly an engineer in U. S. Government employ, salesman and sales manager for the Diehl Manufacturing Co. and manufacturers' representative handling a number of mechanical lines. He entered upon his new association on July 1.

Mr. **A. W. Phillips,** for the past year general superintendent of the Aetna Chemical Co.'s Canadian smokeless powder plant at Drummondville, P. Q., has resigned this position to accept immediately the superintendency of the Canadian Electro-Products Co.'s synthetic acetone plant at Shawinigan Falls, Quebec. R. A. Lockerby, who has been the operating superintendent at Drummondville, succeeds Mr. Phillips in the position. Mr. Phillips formerly was superintendent of the Aetna Explosive Co.'s guncotton plant at Gary, Ind.

Mr. **Forest Rutherford,** for many years superintendent of Reduction Works for the Copper Queen Consolidated Mining Co. at Douglas, Ariz., severed his connections with the company on June 1 and will go into business for himself as a consulting metallurgical engineer. His present address is c/o First National Bank, Pueblo, Col.

Obituary

Prof. **K. Birkeland** of Christiania, the eminent Norwegian engineer who developed, in conjunction with Dr. Sam Eyde, the well-known Birkeland-Eyde nitrogen fixation process, passed away in Tokyo on June 18.

Professor Birkeland, who was born in December, 1867, was educated at the University of Christiania, and subsequently studied in Paris, Geneva and Bonn. In 1898 he became professor of physics at the University of Christiania, but prior to this he contributed a number of interesting papers on electric waves, on cathode rays and on atmospheric electricity to "Wiedemann's Annalen," the "Comptes Rendus," etc. On three occasions he got together and led expeditions for studying the polar aurora and magnetic disturbances, and the results of these expeditions have been published in Christiania and London. During some experiments in 1903 he discovered a special electric high-tension "disk flame." From this as a starting point, he and Dr. S. Eyde worked out a practical method for the production of nitrates from the air and as a result great manufactories for developing this process have been erected in Norway.

The results of this work were completely described in our Volumes II, III and IV, including a paper read before the Faraday Society by Professor Birkeland in 1906.

The Société Norvégienne de l'Azote et de Forces Hydro-Electriques are the owners of the Birkeland-Eyde patents, and at the beginning of 1908 the great Notodden-Svalgfos works were opened with 40,000 hp. Subsequently the company constructed works at Lienfos (15,000 hp.) and Wamma (55,000 hp.). With the Badische Anilin and Soda Fabrik, and two other German companies which possess their own method (the Schonherr), the Norwegian Nitrate Company has formed subsidiary companies which possess plants at Rjukan (227,000 hp.), Tyin (81,000 hp.) and Matre (83,000 hp.). Professor Birkeland was an honorary member of several learned societies.

CURRENT MARKET REPORTS

The Iron and Steel Market

The pig iron, unfinished steel and finished steel markets have come to a dead stop. In finished steel the buying had been of diminishing volume since April, the forward deliveries being more and more neglected while the early deliveries were largely unobtainable. The pig iron market had seen its greatest activity and its last price advances in June. Then, after the iron and steel price-control feature had been dropped from the food bill in the Senate, President Wilson published his statement urging mine owners and manufacturers to "forego unusual profits" and enunciating the "one price for all" doctrine, *i.e.*, for the Government, its Allies, and the general public. Business, already of small proportions, then ceased altogether.

That was a very easy thing for the market to do in a period of heavy demand. When times are dull no one buys ahead and if operations are at only one-half capacity it is necessary for business to be done almost every day. When everyone has bought far ahead, consumers are covered and producers' order books are filled, it is not necessary for new business to be done.

It was a combination of influences that brought the market to a stop. In the first place, prices had gone altogether too high all along the line. In the second place, there were no longer any prices for finished steel products for regular forward delivery. The Steel Corporation subsidiaries practically withdrew from the market in April, and afterward the quoted prices advanced, but they were really prices for early deliveries, what would be called premium prices if there were regular forward prices with which to compare them. In the third place, jobbers and manufacturing consumers became doubtful what their requirements really would be six months or more hence, with the country at war, labor scarce, and conditions generally changed. In the fourth place, Government fixing of prices was more or less expected either in the near or more distant future. Finally, President Wilson enunciated the "one price for all" doctrine, and that was the last thing needed to cause buyers to decide to stop and await developments.

Even if there were no influence whatever from Washington, the course of the market would be one of no activity for a period of months, except for occasional oddlot buying, until a new price level should be established. On such an occasion in the past prices have dropped to a point not far from the cost of production, buying being then resumed and being stimulated by the price advances that would follow. In present circumstances the case is different. The mills are not sold as far ahead as they usually become on such a protracted price advance as that of the past two years and a half, partly because they have been reserved in their sales policy and partly because buyers have also been reserved during the past few months.

There are various influences from Washington, however. The Government is to make large purchases of steel for itself and its allies. How large these purchases will be no one ventures now to predict, but the estimates of 30 days or more ago, that they may run to 40 or 50 per cent of the productive capacity, now seem to be rather high. It is no longer to be considered a foregone conclusion that they will take up the slack that is to be produced by a lighter scale of buying by the general public. The Bridge Builders' and Structural Society, for instance, reported that the fabricated steel bookings in June represented only 47½ per cent of a month's fabricating capacity, against 56½ per cent for May, also a small amount. The railroads have ceased buying entirely.

Another influence from Washington is the fixing of prices on steel for the Government. These prices are expected to be made within a few weeks, orders placed meanwhile being subject to the price to be set later. Last March, when special prices for the Government were under discussion, there were many steel manufacturers who objected on the ground that to give the Government a special price would mean that the whole market would work down to that level. Now, when it is settled that the Government is to have a special price, they doubtless prefer to express another view, but President Wilson has thrown the weight of his influence in the direction of one price for all. If the buyers also adopt his view they may be as successful in getting the market down as they have hitherto been in working it up, for it was chiefly competition among buyers, when mills professed an indisposition to sell far ahead, that produced most of the advance in the market.

The only prices that can be quoted for the market are prices for delivery in the next few months, which very few mills can compass, the following figures giving a rough idea: Bars, 4.50c. to 5c.; structural shapes, 4.50c. to 6c.; plates, 9.50 to 10c.; blue annealed and black sheets, 9c.; galvanized sheets, 11c. to 12c.; steel pipe, 42 per cent off list; nails, $4 per keg.

PIG IRON

The pig iron markets have come to a complete halt. Unlike the finished steel market, pig iron was being sold for regular forward deliveries, at prices substantially the same as those ruling on small lots for early shipment. On the prices ruling since late in June a little iron has been sold for the remainder of this year, with a considerable tonnage for the first half of 1918. The furnaces are sold up practically full for the remainder of this year, and to the extent of perhaps 40 or 50 per cent of their output for the first half of next year. In the second half of July there has been scarcely any business done. The fact that furnaces have not reduced asking prices is no evidence that they do not expect lower prices. It is never productive of business to cut prices after such an advance. Prices at all northern furnaces are a trifle above $50, at furnace, while Alabama iron is a shade under $50.

Non-Ferrous Metal Market

Wednesday, July 25.—There was very little activity in any of the metal markets during the past two weeks owing to the fear of Government regulation of prices. Labor troubles in the West are still holding up production. Copper is considerably lower and lead is lower in the outside market. Tin is virtually unchanged and spelter fractionally lower.

Copper.—The copper market has been very dull and little business has been done. Lake has dropped from 28.50 to 25.50 and electrolytic has dropped from 29.00 to 26-26.50. Some business has probably been done at slightly lower figures than this.

Tin.—About the only thing of importance in the tin market has been the scarcity of spot Straits, the price of which is now 62.50, or about ½ cent higher than on July 16. Tin is coming in regularly without loss. Chinese and Banca tin are slightly lower.

Lead.—The feature of the lead market has been the selling by independents at prices ranging down to 10.00 cents. The demand has been very poor. Labor troubles are still holding up production in the West, and on July 23 a slightly firmer tone reigned on this account.

Spelter.—The price of prompt spelter has remained virtually unchanged with fractional variations up and down. It is now about 8.60 New York. The market has been very dull.

OTHER METALS

Antimony, Chinese and Japanese	lb.,	$0.15
Aluminium, No. 1 Virgin, 98-99 per cent	lb.,	.54
Magnesium, metallic	lb.,	2.00-2.50
Nickel, electrolytic	lb.,	.55
Cobalt	lb.,	2.70
Cadmium	lb.,	1.50
Quicksilver	flask,	115.00
Silver	oz.,	.78⅝
Platinum, pure	oz.,	105.00
Palladium	oz.,	110.00

Chemical Market

Coal Tar Products.—The past fortnight has witnessed a generally slow and easier market for practically all items under this classification and the usual

quietness incident to midsummer has prevailed. Stocks have accumulated in most cases and consumers have, as is usual in a weak market, shown little if any desire to buy.

Benzol.—Reports from practically all factors indicate rather ample supplies of benzol for nearby deliveries and with the basic material for the majority of coal tar products showing a tendency to weakness the general line of subsidiary products reflected this condition. Sales during the two weeks have been strictly confined to actual wants of buyers who are not inclined to purchase ahead in view of the easy tendency prevailing. On contracts there is a tendency on part of firms controlling supplies to hold off and business of this character has been unimportant.

Toluol.—The conditions governing benzol have found reflection in the market for next higher fraction to a minor degree however. Spot supplies have accumulated somewhat but important quantities of toluol are not generally reported in dealers' hands for immediate shipment. Spot values have receded somewhat and minor contracts covering deliveries for the next two months have been put through at very attractive figures. Contracts, however, are difficult to secure. Most firms in control of supplies are well sold. Several inquiries are in the market for large quantities but in view of the uncertainty as to the desires of the government these have not been closed.

Phenol.—A weak market continues and there does not appear to be any immediate hopes of relief for the manufacturer. A large production continues and this bears prices. Consuming demand from domestic sources is meagre and the only important transaction noted lately was for a large shipment to the Orient which was placed at the lowest figure so far prevailing this year.

Benzoic Acid.—The production continues at such an unusual extent that prices have sagged to the lowest level that has prevailed since the beginning of the war. Offers have been made under the $4 mark but it is rumored that manufacturers in their own interest will curtail the output which seems to be in excess of the consumption. The same conditions prevail in the market for *Benzoate of Soda.*

H Acid.—The entry of several new producers into the manufacture of this product has not so far resulted in lower prices. A firm of substantial standing is offering the product at 4½ cents per unit, material generally testing 82 per cent. This price, however, brings the cost of direct colors to a level that will allow of but limited competition with the large, old established firms producing their own H acid.

Gamma Acid.—There has been a production in a liquid form of this material in the Middle West for the consumption of the producer. It is now stated that a dry salt will shortly be marketed by this firm and in addition at least one other producer will shortly be in position to deliver.

Paramidophenol.—A larger production of this material is noted and while the older manufacturers are holding to previous quotations the new operators are cutting prices. The same conditions seem to prevail with *paraphenylenediamne.*

Salicylic Acid.—In contrast to other coal tar products the demand for this product has probably exceeded the supply one hundred to one. Production is centered in few hands but active and rapid preparation is being made to increaes the output and the market will probably go through the same process of elimination noted last year. This condition prevails in *salicylate of sodium* and *salol.*

HEAVY CHEMICALS.—The weakness in the market for *bleaching powder* seems to be the outstanding item of interest during the two weeks. Prices have sagged and sagged until the bottom more than dropped out. The product is a difficult one to move in the summer but no one expected a price that closely approximated pre-war times. *Caustic soda,* however, after a temporary weakness of one or two days strengthened and prices are again higher. This product continues to be the item of most interest to the chemical speculator. *Soda ash* has revealed firmness especially in futures. Spot supplies have been meagre and the demand has been rather urgent. *Copper sulphate* has moved slowly with a tendency to improve as we write. Prices are quietly firm. *Cyanides* are easier and not in special demand. Imports from England are somewhat heavier than usual. *Chlorates* have remained neglected. Domestic business is obtainable on a basis equal to that for export, so anxious are holders for business. *Epsom salts* are somewhat easier and supplies are more easily secured. *Formaldehyde* after a long period of firmness has eased off but supplies are not by any means large. *Phosphorus compounds* have continued scarce and high but a few cases have generally been obtainable from time to time. *Sodium nitrite* has remained practically out of the market and sales have passed above the 50c. level. This compares with a normal price of about 6c. Several productions are planned and contracts are being offered. *Nitrate of Soda* has sold at a record price and importers continue to express bullish views. *Sulphate of ammonia* has been practically eliminated from the market aside from contract business. An offer of 100 tons is very unusual. Prices have soared to unheard-of levels.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 23, 1917

Acetic anhydride	lb.	1.70 —	1.90
Acetone, drums	lb.	.32 —	.33
Acid, acetic, 28 per cent	lb.	.05 —	.05½
Acetic, 56 per cent	lb.	.10 —	.11
Acetic, glacial, 99½ per cent, carboys	lb.	.34 —	.35
Boric, crystals	lb.	.13 —	.13½
Citric, crystals	lb.	.72½—	73
Hydrochloric, commercial, 18 deg	lb.	.01½—	.01½
Hydrochloric, 20 deg	lb.	.01¾—	02
Hydrochloric, C. P., conc., 22 deg	lb.	.02 —	.02¼
Hydrofluoric, 30 per cent, in barrels	lb.	.04¾—	05
Lactic, 44 per cent	lb.	11 —	.12
Lactic, 22 per cent	lb.	.04½—	.05
Nitric, 36 deg	lb.	.06 —	.06½
Nitric, 42 deg	lb.	.08 —	.08¼
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 85 per cent	lb.	.33 —	.37
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3 50 —	4 00
Sulphuric, 60 deg	ton	19.00 —	21 00
Sulphuric, 66 deg	ton	29.00 —	30 00
Sulphuric, oleum (Fuming), tank cars	ton	38.00 —	40.00
Tannic, U. S. P., bulk	lb.	.95 —	1.00
Tartaric, crystals	lb.	.78 —	.81
Tungstic, basis 100 per cent	lb.	1 80 —	
Alcohol, grain, 188 proof	gal.	4.00 —	4.02
Alcohol, wood, 95 per cent	gal.	1 00 —	1.02
Alcohol, denatured, 180 proof	gal.	1.00 —	1.02
Alum, ammonia lump	lb.	.04¼—	04¾
Alum, chrome ammonium	lb.	.19 —	.20
Alum, chrome potassium	lb.	.30 —	.32
Alum, chrome sodium	lb.	.12 —	.12½
Alum, potash lump	lb.	.07½—	.08
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03 —	.03¼
Ammonia aqua, 26 deg. carboys	lb.	.07 —	07½
Ammonium carbonate	lb.	13 —	.14
Ammonium nitrate	lb.	.16 —	.17
Ammonium, sulphate domestic	100 lb.	6 25 —	6 35
Amyl acetate	gal.	4 50 —	4 60
Arsenic, white	lb.	.17 —	.18
Arsenic, red	lb.	.50 —	.60
Barium chloride	ton	90 00	100 00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	04½
Barium nitrate	lb.	.10½—	.11
Barium peroxide, 80 per cent	lb.	.28 —	.30

Bleaching powder, 35 per cent chlorine	lb.	.01¼	—	.01¾
Borax, crystals, sacks	lb.	.07¾	—	.08
Brimstone, crude	ton	30 00	—	
Bromine, technical	lb.	.80	—	.90
Calcium acetate, crude	per 100 lb.	5 25	—	5 50
Calcium carbide	ton	80.00	—	90 00
Calcium chloride, 70-75 per cent, fused, lump	ton	30.00	—	31 00
Calcium peroxide	lb.	1 60	—	1 65
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.	.10	—	.12
Carbon bisulphide	lb.	.06½	—	.07
Carbon tetrachloride, drums	lb.	.16	—	.16½
Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.07½	—	.07¾
Chlorine, liquid	lb.	.15	—	.40
Cobalt oxide	lb.	1 60	—	1 65
Copperas	100 lb.	1 00	—	1 05
Copper carbonate	lb.	.32½	—	.35
Copper cyanide	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals	lb.	.09½	—	.09¾
Cream of tartar, crystals	lb.	.48½	—	.50
Epsom salt, bags	100 lb.	3 75	—	4 00
Formaldehyde, 40 per cent	lb.	.17	—	.18
Glauber's salt	100 lb.	.72	—	.80
Glycerine, bulk, C. P.	lb.	.62½	—	.63
Iodine, resublimed	lb.	4 25	—	
Iron oxide	lb.	.02	—	.08
Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.12¾	—	.13½
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.08	—	.19
Lithium carbonate	lb.	1 02	—	1 05
Manganese dioxide, U. S. P.	lb.	.45	—	.55
Magnesium carbonate, tech.	lb.	.13½	—	.14
Nickel salt, single	lb.	.14	—	.14½
Nickel salt, double	lb.	.11	—	.12
Phosphorus, red	lb.	1 18	—	1 20
Phosphorus, yellow	lb.	2 45	—	2 50
Potassium bichromate	lb.	.35½	—	.36
Potassium bromide granular	lb.	1 35	—	1 40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.49	—	.50
Potassium cyanide, 98-99 per cent	lb.	2 30	—	2 50
Potassium iodide	lb.	2 90	—	2 92
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	350 00	—	360 00
Potassium nitrate	lb.	.31	—	.33
Potassium permanganate	lb.	4 00	—	4 10
Potassium prussiate, red	lb.	2.50	—	2 55
Potassium prussiate, yellow	lb.	1.05	—	1 10
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	325 00	—	350 00
Rochelle salts	lb.	.39	—	.39½
Sal ammoniac, grav gran	lb.	.10	—	.11
Sal ammoniac, white gran	lb.	.15	—	.18
Sal soda	100 lb.	1.15	—	1 25
Salt cake	100 lb.	.90	—	1 00
Silver cyanide	oz.		—	
Silver nitrate	oz.	.50	—	.52
Soda ash, 58 per cent, light, flat	100 lb.	2 80	—	2 90
Soda ash, 58 per cent, dense, flat	100 lb.	3 65	—	3 75
Sodium acetate	lb.	.09	—	.10
Sodium benzoate	lb.	4 00	—	4 50
Sodium bicarbonate, domestic	100 lb.	2 35	—	2 50
Sodium bicarbonate, English	lb.		—	
Sodium bichromate	lb.	.15¾	—	.16
Sodium bisulphite, powd	lb.	.03½	—	.04
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.52	—	.53
Sodium fluoride, commercial	lb.	.17½	—	.18
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4 27½	—	4 30
Sodium nitrite	lb.	.45	—	.55
Sodium peroxide	lb.	.85	—	.90
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.30	—	.32
Sodium silicate, liquid—40 deg. Baumé	100 lb	2 00	—	2.50
Sodium sulphide, 30 per cent crystals	100 lb.	2 00	—	2 10
Sodium sulphide, 60 per cent, fused	100 lb.	3 00	—	3 50
Sodium sulphite	lb.	.03¾	—	.04½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.09½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	3 95	—	4 10
Sulphur, roll	100 lb.	3 70	—	3.85
Sulphur, crude	ton	30 00	—	35 00
Tin bichloride, 50 deg.	lb.	.19¼	—	.19½
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	
Zinc dust, 350 mesh	lb.	.17	—	.17½
Zinc oxide, American process XX	lb.	.14¾	—	.15
Zinc sulphate	lb.	.05½	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.53	—	.55
Benzol, 90 per cent	gal.	.53	—	.55
Toluol, pure, water white	gal.	1 70	—	1 80
Xylol, pure, water white	gal.	.50	—	.55
Solvent naphtha, water white	gal.	.19	—	.23
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.31	—	.33
Dip oil, 20 per cent	gal.	.28	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 00	—	1 05
Carbolic acid, crude, 50 per cent	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P.	lb.		—	

Intermediates, Etc.

Alpha naphthylamin	lb.	.75	—	.80
Aniline oil	lb.	.29	—	.30
Aniline salts	lb.	.34	—	.35
Anthracene, 80 per cent	lb.	.10	—	
Benzaldehyde	lb.	1 00	—	4 50
Benzidine, base	lb.	1 80	—	1 90
Benzidine, sulphate	lb.	1 55	—	1 60
Benzoic acid	lb.	4 50	—	4 75
Benzyl chloride	lb.	1 75	—	2.00
Beta naphthol benzoate	lb	8 50	—	9 00
Beta naphthol, sublimed	lb.	.75	—	.76
Beta naphthylamin crude	lb.	2 50	—	
Dichlor benzol	lb.	.11	—	.20
Dinitrochlorbenzol	lb.	.44	—	.46
Dimethylaniline	lb.	.58	—	.60
Diphenylamine	lb	.95	—	1.00
H-acid	lb.	3 25	—	3.50
Metaphenylenediamine	lb.	1 75	—	1 80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09	—	.09¼
Naphthionic acid, crude	lb.	1 50	—	1 75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.		—	
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	5 00	—	6 00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3 50	—	3 75
Para toluidine	lb.	1 85	—	2.10
Phenol, U. S. P.	lb.	.40	—	.42
Resorcin, technical	lb.	8 00	—	9 00
Resorcin, pure	lb.	14 00	—	15 00
Salicylic acid	lb.	1 50	—	1.75
Salol	lb.	1.85	—	2 00
Sulphanilic acid	lb.	.32	—	.33
Tolidin	lb.	3 00	—	
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3 10	—	....
Corning, Ohio	bbl.	2 40	—	....
Somerset, Ky	bbl.	2.20	—	....
Wooster, Ohio	bbl.	2.18	—	....
Indiana	bbl.	1 78	—	....
Illinois	bbl.	1.92	—	....
Oklahoma and Kansas	bbl.	1.70	—	....
Caddo, La., light	bbl.	1.90	—	....
Corsicana, Tex., light	bbl.	1.70	—	....
California	bbl.	.98	—	1 29
Gulf Coast	bbl.	1 00	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .905 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	....
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....

Vegetable and Other Oils

China wood oil	lb.	.17	—	.19
Cottonseed oil, crude	gal.	1.07	—	
Linseed oil, raw, cars	gal.	1.11	—	
Peanut oil, crude	gal.	1 15	—	
Rosin oil, first run	gal.	.39	—	
Rosin oil, fourth run	gal.	.66	—	
Soya bean oil, Manchuria	lb.	.14½	—	
Turpentine, spirits	gal.	.42	—	

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38 00	—	40 00
Barytes, floated, white, domestic	ton	28 00	—	32 00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, fair	lb.	.53	—	
Casein	lb.	.19	—	.28
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8 00	—	12.00
Fuller's earth, powdered	100 lb.	1 00	—	1 50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American	lb.	.35	—	
Red lead, dry, carloads	lb.	.13	—	
Rosin, 280 lb	bbl.	5 70	—	
Soapstone	ton	10 00	—	12 50
Talc, American, white	ton	10 00	—	13 00
White lead, dry	lb.	.11½	—	

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	45 00	—	50 00
Clay brick, second quality	per 1000	30.00	—	
Magnesite, raw	ton	30 00	—	35 00
Magnesite, calcined	ton	40 00	—	55.00
Magnesite, Grecian, dead burned	net ton	90 00	—	
Magnesia brick, Grecian, 9x4½x2½	net ton	140 00	—	
Silica brick	per 1000	50 00	—	

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	
Ferrochromium	lb.	.20	—	
Ferromanganese, domestic, delivered	ton	400.00	—	425 00
Ferromanganese, English	ton	200.00	—	
Ferromolybdenum, per lb. of Mo	lb.	4.50	—	
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200.00	—	225 00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.65	—	
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

Aniline Bases Co., 1 Newark Street, Hoboken, N. J., $120,000. Manufacturing dyes, chemicals, etc.

Arkansas City Refining Company, Wilmington, Del., $500,000. Incorporators: Harry Emmons, Kenneth L. Emmons, Anna L. Dorsey, of Wilmington

Bookertee Smelting & Refining Co., Henryetta, Okla., $1,000,000. Incorporators: F. R. Bouldin, S. Walker and V. V. Grant, of Bouldin.

The C. P. N. Chemical Company, New York, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals. H. M. Peyser, G. D. Aranow and A. N. Harris, 320 Broadway, are the incorporators.

The Charleston Alloy Steel Company, Belle, W. Va., has been incorporated with a capital of $500,000, to operate a local plant. J. M. Payne, Berkeley Minor, Jr., and G. P. Brennan, all of Charleston, are the incorporators.

The Chemical Apparatus Manufacturing Company, Wilmington, Del., has been incorporated with a capital of $150,000 to manufacture chemicals. C. L. Rimlinger, and Henry M. Robinson, Wilmington; and Clement M. Egner, Elkton, Md., are the incorporators.

Chicago—Miami Lead & Zinc Co., Miami, $150,000. Incorporators: Wallace E. Shirra, Claude K. Church, Chicago; Charles McCafferty, Oklahoma City.

Corona Salt Co., Inc., Groton, N. Y., $425,000. Oil, gas and salt production. Incorporators: F. R. Miller, 120 East Eighty-ninth Street, New York City; E. A. King, 1215 Union Avenue, Bronx; S. M. Bell, Montclair, N. J.

The Dittenhoefer Tube & Rubber Company, New York, has been incorporated in Delaware with capital of $1,000,000, to manufacture automobile tires and tubing. Arthur W. Britton, Samuel B. Howard and John A Moore, all of New York City, are the incorporators.

The Durham Paper & Pulp Company, Phillipsburg, N. J., has been incorporated with a capital of $125,000, to operate a local plant. Walter L. Cochran, O. S. McConnell and E. Hulings Antrin are the incorporators.

East Chicago Foundry Company, East Chicago, Ind., $30,000, foundry. Directors: Harry C. Stuart, Henry S. Evans, Phili S. Graver, William F. Graver.

The Franklin Paint Co., Cleveland, Ohio, $10,000. F. H. Meier and others, incorporators.

The Great Western Potash Company, San Diego, Cal., has been incorporated in Delaware with a capital of $1,000,000, to manufacture potash and aluminum. J. A. and E. M. Henry, and W. E. Shaw, all of San Diego, are the incorporators.

Havemeyer-Seamans Oil Company, $10,000,000, acquire oil and gas lands and develop the same, construct railroads, etc. Incorporators: C. L. Rimlinger, Henry M. Robinson, Clement M. Egner, Wilmington, Del.

Independent American Oil & Sulphur Corporation, Wilmington, Del., $15,000,000. Incorporators: A. M. Holleran, M. H. Morris, Ferris Giles of Wilmington.

Kentucky Oil Company, Ashland, $200,000. Incorporators, Marshall Bond, Henry F. Benn, Frank M. Laird and C. C. McCoc.

Joseph G. Kessler & Co., Inc., Brooklyn, N. Y., $45,000. Smelting and refining zinc ore and its products. Incorporators: J. G. Kessler, B. Goldberg, 105 Kent Street, Brooklyn.

The Keystone Chemical Supply Company, Philadelphia, Pa., has been incorporated with a capital of $50,000 to manufacture chemicals. G. A. Street is the principal incorporator.

Lambert-Georgian Chemicals Corporation, Manhattan; capital $100,000. Drugs and chemicals. Frances Kriegel, Maurice Hotchner and Luis F. Cores.

The Lee Paper Box Company, Philadelphia, Pa., has been incorporated with a capital of $15,000 to operate a local plant. Edwin A. Lee is the principal incorporator.

W. C. McBride, Inc., Wilmington, Del., $100,000. Petroleum and natural gas. Incorporators: C. L. Rimlinger, Henry M. Robinson, Clement M. Egner.

The Massillon Steel Castings Co., Massillon, Ohio, has been incorporated for $250,000. The new steel plant will begin operation in a short time.

Montezuma Mining & Reduction Corp., $1,000,000, do a general mining business in all its branches. Incorporators: M. L. Rogers, H. W. Davis, L. A. Irwin, Wilmington, Del.

Nica Refining Co., Washington, D. C., $100,000. Incorporators: A. H. Coombs, H. P. Olden, of Washington.

The Oklahoma Consolidated Producing & Refining Co., Wilmington, Del., $5,000,000. The business of drilling and marketing oil, natural gas, etc.

Ossining Chemical Works, Inc., Ossining, N. Y., $25,000. Alkalies, drugs, and chemicals. Incorporators: A. F. McCabe, H. W. Bense, H. S. Ferrigro, 37 Wall Street.

The Ouachita Cotton Oil Company, of Camden, Ark., $60,000 ($37,000 subscribed). Incorporators: W. H. Warnock, T. S. Grayson, D. P. Baker, W. W. Boyd, A. A. Reid, J. O. Hutcheson, James G. Brown, J. L. Davis and C. W. McKay.

The Penn Paper Products Company, Philadelphia, Pa., has been incorporated with a capital of $50,000 to manufacture paper goods. LeRoy Jacobs, Philadelphia; Cyrus E. Tomlinson, McKinley, Pa., and George L. Townsend, Jr., Wilmington, Del., are the incorporators.

The Potash Extraction Corporation, New York, N. Y., has been incorporated with a capital of $100,000, to operate crushing plants and quarries for felspathic rock. G. F. McKay, D. Lillis and A. A. Alexander, 2 Rector Street, are the incorporators.

Priest-Lee-Bell Oil Corporation, Wilmington, Del., $300,000. To refine, market and develop crude oil and its products.

The Radiant Glass Company of Fort Smith, Ark., $10,000, filed articles of incorporation. Incorporators: George D. Carney, M. N. Carney and J. S. Parks.

The Sotter Brass Foundry Company, Pittsburgh, Pa., has filed articles of incorporation with a capital of $10,000, to operate a local plant. Charles J. Sotter is the principal incorporator.

The Southern Ferro Alloys Company, Chattanooga, Tenn., has been incorporated with a capital of $200,000, to operate a plant for the production of ferrosilicon, ferrochrome and kindred alloys. It is said that the company has acquired a site for the proposed plant and will commence operations with three electric furnaces. P. J. Kreusi is president of the company.

The Stalnaker Steel Company, Pittsburgh, Pa., has been incorporated with a capital of $150,000 to operate a local plant. Harvey D. Stalnaker is the principal incorporator.

Standard Asphalt and Refining Company, $5,000,000, to refine and market oil and products thereof. Incorporators: L. E. Phillips, J. B. Bailey, Dover, Del.

The Standard Tungsten Company, Newark, N. J., has been incorporated with a capital of $100,000, to manufacture tungsten specialties. R. T. Rodger and G. Dazet are the principal incorporators. C. H. Vail, 810 Broad Street, is agent for the company.

The Superior Glass Manufacturing Company, Martins Ferry, Ohio, has been incorporated in West Virginia, with capital of $50,000, to operate a local plant. Frank A. McMahon and R. R. Marshall, Wheeling, and William W. Davis, Cumberland, Md., are the incorporators.

The Sweetser & Bainbridge Metal Alloy Company, Albany, N. Y., has been incorporated with a capital of $10,000 to manufacture metal alloys and metallic compounds. S. P. Sweetser, E. F. Bainbridge and H. G. Batcheller, Albany, are the incorporators.

The Tennessee Paper Mills Company has been incorporated with a capital of $200,000 to manufacture paper boxes. The new factory will make two kinds of paper, straw board and chip board.

Transportation Petroleum Company, New York, $1,000,000: F. Fried, G. M. Healy, New York; Liciam Ross, San Antonio, Tex.

The United States Nitrates & Ammunition Company, New York, N. Y., has been incorporated in Delaware with a capital of $100,000 to manufacture nitrates of soda products and other specialties. William L. Underwood, Patchogue, L. I.; George E. Wilson, New York; and Elmer E. Fowler, Spencer, N. Y., are the incorporators.

Virginia Chlorine Products Co., Newark, N. J., $1,500,000, chemicals. Incorporators: Henry Van Arsdale, Jr., Newark; C. J. Kulberg, New York.

The White Chemical Company, Louisville, Ky., has been incorporated with a nominal capital of $5,000 to manufacture chemicals. I. L. and Emile Steinfeld and W. G. Rork are the incorporators.

Capital Increases

The Erie Iron & Steel Company, Erie, Pa., has increased its capital from $100,000 to $500,000.

The Hewitt Rubber Company, 240 Kensington Street, Buffalo, N. Y., has increased its capital from $1,000,000 to $1,500,000. The company specializes in the manufacture of air brake hose for locomotive service.

The Buffalo Pressed Steel Company, Buffalo, N. Y., has recently increased its capital from $30,000 to $75,000.

The Minotola Glass Company, Minotola, N. J., has increased its capital from $100,000 to $500,000 for expansion.

Construction and Operation

California

INDIAN FALLS.—The Noble Electric Steel Company, which is already engaged in producing electrically smelted steel in commercial quantities at its plant in Heroult, Shasta County, has taken a lease upon the manganese mining property originally located by Messrs. Mason and Braito, situated at the "watering trough" near Indian Falls.

J. Carey is superintending the development work which is now being started. It is reported that the company intends to build a 700-foot tramway and to prosecute the work with a crew of 30 or 40 men. The manganese property is situated almost on the line of the Indian Valley Railroad.

MARTINEZ.—The Shell Oil Refinery will expend $1,000,000 on its plant. A contract has been let for nine 55,000-barrel steel tanks.

REDDING (Shasta County).—At a special meeting of the directors of Noble Steel Electric Company, operating at Heroult on the Pitt River, W. H. French, vice-president and general manager of the Judson Manufacturing Company, has been elected vice-president and general manager. H. H. Noble, the man who developed the plant at Heroult, retains his stock in the company, but it is understood he has given his proxy to French.

The new general manager has been head of the Judson company for five years and during that time increased the business from one-quarter to three millions a year. Already he has made arrangements with the United States Government to take the ferromanganese, ferrochrome and ferrosilicon being turned out at Heroult.

H. E. Bothin, president of the Judson Manufacturing Company, is backing French in his venture at Heroult.

Dr. W. W. Clark will remain in charge of all plant operations.

The plant now has two furnaces working 24 hours a day; one on ferromanganese, turning out 8 to 10 tons every 24 hours, and the other on ferrosilicon, turning out 5 tons every 24 hours. The company also has ready three small furnaces, each of which will turn out one and a half tons of ferrochrome every 24 hours.

Slow shipments of electrodes from the East and freight tieups have held down production at Heroult, but the railroads have assured the new management that since they are making ferroalloys all materials will be rushed.

SAN BERNARDINO.—Building of a sodium reduction plant in San Bernardino

will begin within a few days. Sodium deposits on the desert will furnish the material.

SAN FRANCISCO.—A $350,000 refining plant for cocoanut oil is contemplated in San Francisco. Mr. C. E. Johnson of Milwaukee, president of the Johnson Manufacturing Company, is looking for sites.

SAN FRANCISCO. — The Fleischhaker Paper Co. has taken a lease on a 4-story 123 x 130 ft. reinforced concrete factory to be built at Second and Harrison Streets by the Clinton Construction Co., Twenty-first and Treat Streets. It was purchased for $125,000.

SAN FRANCISCO.—Plans have been completed for the 1-story mill and foundry building to be erected for the Jewell Steel & Malleable Company at Potrero Avenue and Twenty-fifth Street. The building will cover an area of 148 by 108 feet. Further extensions will be erected as soon as this unit has been completed.

SAN FRANCISCO.—Potash is said to be the secret of the recent declaration of a 13 per cent stock dividend to the shareholders of the Santa Cruz Portland Cement Company, on stock of record July 14. A large stockholder of the company said yesterday tha the Santa Cruz is no wmaking 600 pounds of potash daily, with only a single unit of an inexpensive plant in place and in operation. This potash is a by-product, extracted from the flue dust and fumes generated in making the cement. It is figured that with eight kilns in operation the company ought to make two tons of potash daily.

Delaware

WILMINGTON.—The Harlan & Hollingsworth Corporation, West Street, has filed plans for the erection of a new copper and tin shop at its shipbuilding plant.

WILMINGTON.—The Wilmington Steel Company, it is said, is planning for the rebuilding of its 18-inch mill and other sections of the plant recently destroyed by fire with loss of about $150,000. The Midvale Steel Company, Philadelphia, operates this organization.

Florida

JACKSONVILLE.—General Manager J. C. O'Dell of the Municipal Docks and Terminals announced recently that he had concluded arrangements with F. M. Whittle, manager of the Florida division of the Virginia-Carolina Chemical Company, to have the branch plant of that company located on the properties of the Municipal Docks and Terminals near the St. Johns Mill Road. The space will be approximately three acres, and will have buildings on it to cost between $150,000 and $250,000. These buildings consist of warehouses and manufacturing plants and an acid tower.

Idaho

WALLACE.—The Tamarack & Custer Mining Company has resumed work on its properties in the Cœur d'Alenes after a lull of three months. The company, which owns a half interest in the smelter at Northport, Wash., according to a report, will send its ore to the Bunker Hill & Sullivan smelter at Kellogg. This move is taken on account o fthe difficulty in getting coke at Northport.

Illinois

CHICAGO.—The Marks Manufacturing Company will expend $14,500,000 in the construction of its new steel works at East Chicago, which is $9,500,000 in excess of the estimated cost a year ago. A 600-ton blast furnace, complete with docks, ore and coke handling machinery, an open-hearth steel department with a capacity of 250,000 gross tons of ingot a year, and a universal plate mill with a capacity of 180,000 gross tons of universal and sheared plates will be added.

Iowa

DES MOINES.—A deal was closed to-day for the purchase of an acre of land at East Twenty-sixth Street and Dean Avenue by the Keith Furnace Company of 336 Southwest Eleventh Street. It is planned to erect a four-story factory and a large one-story foundry, which will be a modern, fireproof, daylight type building. R. S. Keith is owner of the plant.

Kentucky

HELLIER.—The Allegheny Coke Company is reported to be planning for the installation of a new battery of coke ovens to double the present output, making a total capacity of about 20,000 tons of coke per month.

Louisiana

NEW ORLEANS.—Steel rolling mill promoters have enlisted the services of a broker to seek a large site on a public belt railroad and served by water transportation. The promoters have incorporated under the law of Delaware as the Dixie Steel Corporation, with a capital of $500,000 to utilize high-grade scrap iron.

Maryland

BALTIMORE.—The Crown Cork & Seal Company, Guilford Avenue, will build a new four-story, reinforced-concrete plant at Foster Avenue and Twelfth Street. The structure will be 30 x 125 ft. and will be equipped for the manufacture of bottle stoppers and kindred specialties.

Minnesota

DULUTH.—The Minnesota Steel Corporation will expend two million dollars for construction work. The enlargement of the plant will begin at once, and includes two blast furnaces and four open-hearth furnaces, costing $1,500,000, plans for which are already under way. Erection of a benzol plant was started some time ago, costing $500,000, and is expected to be in operation in eight months. A second unit of furnaces will be constructed next year, consisting of six blast furnaces and fourteen open hearth furnaces.

MINNEAPOLIS.—A one-story factory building 100 by 120 ft. is being built at Johnson and Broadway, which will be occupied Sept. 1 by the Columbia Chemical Company to manufacture phosphoric acid, caustic soda and fertilizers.

MINNEAPOLIS.—Coincident with the opening today of the Mississippi River navigation to Minneapolis the Columbia Chemical Company announced it will build a plant here and bring Tennessee phosphate rock by river transportation for treatment. The plant will comprise for the present a brick and steel two-story building on ground 100 by 150 feet and a boiler house 40 by 50 feet. The Austin Company of Cleveland has the contract. C. N. Lockwood is secretary of the new company and George Walker, chemist, is the technical head. The plant will make sodium phosphate, caustic soda, phosphoric acid and sodium sulphate.

Montana

BUTTE.—The selection of a site for a rod and wire mill at the plant of the Boston-Montana Smelter of the Anaconda Company at Great Falls, Mont., is officially announced. The mill will involve an expenditure of $700,000 and will have a daily capacity, with only one shift working, of 200,000 pounds of copper rods and 65,000 pounds of copper wire.

GREAT FALLS.—Owing to the strike in Butte, the Washoe smelter of the Anaconda Copper Mining Co. has closed, and the Great Falls smelter has curtailed production. Plant here is out of copper concentrates, and copper refinery is also short. Labor troubles in Butte is reflected by the decrease from 20,000,000 to 8,000,000 pounds of copper for the June output.

HELENA.—Representatives of Pennsylvania steel mills are now in Granite County looking over the ground with a view to erecting a large smelter for the reduction of manganese ore.

HELENA.—Employees of the East Helena smelter of the American Smelting & Refining Company were notified recently of a voluntary increase in pay of 25c. per day, to prevail as long as the sale price of lead is $11 a hundred weight or more.

KELLOGG.—The Bunker Hill & Sullivan Mining & Concentrating Company's big smelter is almost ready for complete operation. Roasters are taking ore, and the furnaces will be blown in within 10 days. The first of the cintering machines has been adjusted and the other four machines will be put in operation. Ore for the first blast will be supplied by the Bunker Hill & Sullivan mine, which made the erection of the smelter possible. The Hecla Mining Company at Burke, Idaho, will become one of the large contributors.

Nebraska

OMAHA.—The United Oil & Refining Company has commenced operations on its 25,000-acre lease in Madill Field, Bryan County. Mr. C. J. Bowman, formerly vice-president of the Southern Oil & Gas Company of Tulsa, is president.

New Jersey

JERSEY CITY.—The American Can Company, 120 Broadway, New York, is reported to be negotiating with the local Chamber of Commerce for a site in the Fairmount Terminal section for the construction of a new plant, to cost about $500,000.

JERSEY CITY.—The Interstate Chemical Company will build a one-story addition to its plant on Garfield Avenue, near Marcus Street.

JERSEY CITY.—The Natural Products & Refining Company, manufacturer of refined oils, etc., will build a new one-story plant at Jane and Commercial Streets.

NEW HOPE.—The Union Paper Bag Company is building an addition to its plant.

NEWARK.—The Balbach Smelting & Refining Company, Avenue R and Doremus Avenue, has filed plans for the construction of two one-story additions to its plant, 49 x 100 ft. and 29 x 90 ft., respectively.

NEWARK.—The Nicklesburg Brothers' Company will build a one-story shop addition, 34 x 40 ft., to its leather manufacturing plant on Meadow Street.

NEWARK.—The Hanson & Van Winkle Company, 269 Oliver Street, manufacturer of chemicals, etc., will build a new two-story plant, 46 x 50 ft., on Adams Street, to cost about $15,000.

PARLIN.—The T. A. Gillespie Company has acquired about 640 acres of property in the vicinity of its powder plants at Parlin and Runyon, and is reported to be planning for the construction of extensive additions to provide for increased capacity.

PATERSON.—The East Jersey Pipe Corporation, East Thirty-sixth Street, is remodeling and improving its works to provide for the manufacture of shells. New machinery is being installed. It is planned to commence operations early in August.

PERTH AMBOY.—The General Bakelite Company, manufacturer of insulation specialties, has commenced the erection of a five-story addition to its plant, about 50 x 80 ft., to be used for increased capacity. The company is a subsidiary of the Roessler & Hasslacher Chemical Company, Fayette Street, Perth Amboy.

ROCKAWAY.—The New York & New Jersey Chemical Company has been organized to take over the former plant of the Lincoln Architectural Iron Company, and equip and operate the works for the manufacture of chemicals.

New York

BUFFALO.—The plant of the Buffalo Copper & Brass Rolling Mill Company, 446 Military Road, has recently been acquired by the American Brass Company. The works, which have been used for the manufacture of rolled copper and brass, will be operated at full capacity.

BUFFALO.—The Sizer Forge Company, 238 Larkin Street, manufacturer of steel forgings, is planning to lease property over the Mill Race Strip for extensions to its plant.

FARMINGDALE, L. I.—The Farmingdale Chemical Company has purchased the former plant of the E. C. Nelson Manufacturing Company, to be used for the manufacture of chemicals.

LONG ISLAND CITY.—The Oakes Manufacturing Company, foot of Blackwell Street, manufacturer of dyewood specialties, will build two reinforced-concrete additions to its plant, to consist of a three-story building, 30 x 100 ft., and a two-story structure, 60 x 80 ft.

POUGHKEEPSIE.—Negotiations were concluded recently looking toward the establishment of the Reliance Aniline Chemical Company of Brooklyn in the vacant factory of the Standard Concrete Construction Company.

SYRACUSE.—The Syracuse Malleable Iron Works, North Geddes Street, specializing in the manufacture of metal wheels for motor trucks, is planning to increase the plant capacity from 25 to 40 sets of wheels daily.

TOTTENVILLE, S. I.—The Tottenville Copper Company has filed plans for the erection of a two-story addition to its plant on Bethel Avenue.

WATERVLIET.—The Ludlum Steel & Spring Company, Fifth Street, manufacturer of crucible cast steel specialties, is planning for the erection of a two-story addition to its plant on Spring Street.

Ohio

CLEVELAND. — The Clarke - Kessler Chemical Works has purchased from a Cleveland syndicate 17 acres between the

New York Central tracks and St. Clair Avenue and east of Lloyd Road in Wickliffe for a consideration of about $25,500. The first unit of a chemical plant which will cost about $30,000 has been started.

COLUMBUS.—Work will start soon on the modern factory sheds which are to be built on Bonham Avenue at the plant of the General Chemical Co., to cost about $100,000.

PORTSMOUTH.—The William R. Pollock Co. will soon complete a blast furnace for the Whitaker-Glessner Co., after which resources of the concern will be devoted to building a furnace for the Tate Iron & Steel Co. of Sakchi, India.

Pennsylvania

BETHLEHEM.—The Bethlehem Steel Company has awarded a contract for the construction of a one-story, brick and steel addition, 60 x 120 ft., at its Sparrows Point, Md., plant, to be used as a copper shop. The Singer-Pentz Company, Baltimore, has the building contract.

COLUMBIA.—The Keeley Stove Company, Second and Maple Streets, is planning to increase its capital from $200,000 to $300,000 for extensions.

FAYETTE CITY.—The Pittsburgh Steel Products Company announced recently mammoth building projects, including new plants and a new town and involving an expenditure of more than $3,000,000. The extensions will be located in Allen Township, Washington County, on the Monongahela River. The land was purchased last fall and work has already begun.

LANSDALE.—Fire recently destroyed the plant of the Lansdale Rope Works, with loss of about $20,000. It is said that the plant will be rebuilt. The Barrows Manufacturing Company, Lansdale, operates this property.

MARIETTA.—The National Casting Company is making rapid progress in improving and extending the former plant of the Marietta Manufacturing Company, recently acquired, for the production of iron and steel castings. J. H. Foreman is head of the company.

PHILADELPHIA.—Barclay White & Co. and H. E. Baton are estimating on plans for alterations and additions to the plant of the Surpass Leather Company, at Ninth and Westmoreland Streets.

PHILADELPHIA.—Charles Lennig & Co., manufacturers of chemicals, are building a two-story addition to their plant on Richmond Street, to cost about $11,000.

PHILADELPHIA. — The Philadelphia Drying Machine Company, Westmoreland Avenue, has awarded contracts for the erection of a new plant at Westmoreland Avenue and Stockley Street, to cost $40,000. The new site will be used as the main plant of the company, which specializes in the manufacture of drying machinery, allowing for the removal from its present Germantown works.

PITTSBURGH.—The Cunningham Glass Works properties on the south side is under option to the Jones & Laughlin Steel Company for a price of about $200,000. The property consists of the old glass factory on a lot measuring 360 x 120 feet at Mary and South Twenty-sixth Streets, and two large vacant lots, measuring 252 x 120 feet and 264 x 120 feet on Jane and South Twenty-sixth Streets.

PITTSBURGH.—The Jones & Laughlin Steel Company, Third Street, is said to have acquired an option for the purchase of the plant of the Cunningham Glass Works, Mary Avenue, for about $200,000. It is said that the plant will be used for extensions.

READING.—The Reading Malleable Iron & Steel Company is reported to be planning for the erection of a new plant at Norristown.

Tennessee

CHATTANOOGA.—Actual manufacture of ferroalloys will probably begin in October at the old plant of the Southern Steel Works in Chattanooga, which has been taken over by the Southern Ferro-Alloy Co. Hydroelectric power will be obtained from the Tennessee Power Co., 3000 hp. having been contracted for. The first product of the new company will probably be ferrosilicon, 50 per cent or higher. The plant of the old steel company is fairly well adapted to the new purpose, but three months will be necessary for its remodeling and for the installation of machinery, which was designed by the FitzGerald Laboratories, of Niagara Falls, N. Y.

CHATTANOOGA.—The Tennessee Paper Company, recently organized with capital of $200,000, is planning for the construction of a local plant with capacity of about 50 tons daily. The mill is estimated to cost $150,000. A. M. Shepherd is head of the company.

Texas

HOUSTON.—The contract has just been awarded by Swift & Co. of Chicago for the construction of a cottonseed oil refinery here to cost $250,000. It is stated that a specialty will be made of converting cottonseed oil into a lard substitute and other cooking materials. The buildings will be of fireproof brick and concrete construction.

HOUSTON.—R. S. Sterling, president of the Humble Oil & Refining Company, which was chartered recently at Austin with a capital stock of $4,000,000, stated that they will build a refinery with a capacity of at least 3000 barrels of crude daily at Fort Worth, which will be started as soon as the material can be assembled.

Virginia

GOSHEN.—The Southeastern Iron Corporation, Tower Building, Chicago, recently organized with a capital of $500,000, is reported to be planning to take over the plans of the Goshen Iron Company and the Victoria Iron Company. It is proposed to remodel and improve the works to provide a total capacity of 200 tons daily. The extension is estimated to cost $150,000. Francis H. Hardy is president.

Washington

CHEWELAH.—Handy & Chippendale, who have leased the Double Eagle mining properties near this city, will erect three calcine kilns in the development of the magnesite property.

COLVILLE.—The Crown Willamette Paper Company of Portland, Ore., will develop its dolomite properties near here, the dolomite to replace magnesite in paper making. Field kilns for calcining the dolomite will be installed.

KELLER.—The Manila Copper Mining & Smelting Company, Keller, Wash., has been organized, and will operate a 200-ton smelter in Keller. A smelter at that point, built nine years ago, but never blown in, will form the basis of the plant. Plant has copper stack with 150 tons capacity; lead stack of 50 tons; electric power plant, sampling room and laboratory. Considerable new equipment will be added, and the plant put in operation to handle commercial ores.

NORTHPORT.—The Electric Point Mine has opened up a vein of solid high grade lead carbonates in a body 59 ft. wide. Property is to be developed on a large scale.

NORTHPORT.—The Northport Smelter here, at a cost of $100,000, is putting in a Cottrell plant for the saving of values in the smelter smoke. The smelter has been losing $600 a day through its smoke, and it is claimed this plant will pay for itself in six months.

NORTH YAKIMA.—The Utah Idaho Beet Sugar Company's plant at North Yakima is nearing completion. It will have a capacity of 500 tons of beets per 24-hour day and it is estimated to cost $400,000 to $500,000. A novel feature in the equipment being installed is a pulp dryer which, so far as the Utah Idaho company is concerned, is a new departure.

NORTH YAKIMA.—Harry Y. Saint, secretary of the Commercial Club, states that according to a telegram from Eastern interests, a potato starch factory will be erected in the near future in the city.

PORT ANGELES.—A plant will be established in this city by the Washington Pulp & Paper Company for the extraction of tannin from hemlock bark for use in the tanning industry. Plant will have capacity of 24 cords of bark daily.

SEATTLE.—The Charles A. Newhall Company, chemical and inspection engineers, Seattle, has received contract for inspection of a large order of creosoted timber and creosoted piling, work to be done under U. S. Engineer's Office, Major E. J. Dent. The Newhall Company is associated with the Pittsburgh Testing Laboratory.

SEATTLE.—The Hurley-Mason Company, Hoge Building, has received contract for construction of coal bunkers and 60 beehive coke ovens at Croker for the Carbon Hill Coal Company.

SEATTLE.—The Pacific Coast Steel Company, headed by William Piggott, has purchased the plant of the Oregon Steel & Iron Works at Oswego, Ore., and will put the plant in operation for the manufacture of pig iron, using ores from the west coast of South America. The plant cost $300,000 and was built twenty-five years ago. It has been idle a large part of the time. The Pacific Coast Steel Company also announces the merger of the Seattle Car & Foundry Company of Seattle with the railway car-building plant of Twohy Bros., of Portland and Spokane, under the name of the Pacific Car & Foundry Company. William Piggott is president of the new concern. The company recently purchased and is putting in operation the Irondale plant of the Western Steel Corporation, where blast fornaces are being installed. An extensive program of car building, pig iron manufacture and industrial development is planned by the new corporation.

SPOKANE.—The United Copper Mining Company, according to Conrad Wolfe, president, will immediately double the capacity of its concentrating plant. The plant will have increased capacity of 600 tons daily. New equipment to be installed will include tube mill, 10 tables and classifiers.

SPOKANE.—The American Fire Brick Company's branch plant will be established here at once. An old brick plant has been taken over by President-Manager C. F. Oudin, and will be converted into a plant for manufacture of calcined magnesite, magnesite brick and other magnesite products. All of the machinery in the plant will be scrapped, and new equipment, costing $25,000, will be installed.

SPOKANE.—The Giant Ledge Mining Company, operating large mining properties in the Coeur d'Alenes, plans the installation of a 150-ton mill, which will later be enlarged to twice that capacity.

West Virginia

BELLE.—A deal was closed recently by New York interests for the Slack Farm at Belle, a town 12 miles east of Charleston, on the Kanawha and Michigan side of the river, on which property they propose to construct a million dollar electrical refining plant to refine high-grade chemicals and by-products from other factories now located in the Kanawha district.

MOUNDSVILLE.—W. H. McSwain and associates have organized a company to operate a local plant for the manufacture of glass rolling machinery.

SISTERSVILLE.—The Independent Glass Company is making extensive repairs to its plant which will make it almost like a new plant when it is completed. New tanks and two new ovens are being placed in the plant and the stack has been raised 35 ft. and four new sections of roof have been put in place. Five gas producers will be installed and two 50-horsepower boilers will be added.

WHEELING.—The Wheeling Chemical Products Company, 3102 Jacob Street, has been manufacturing matches, glue and other chemical products since the first of the year and promises to be one of the large match factories of the world.

WHEELING.—The Wheeling Mold & Foundry Company, manufacturer of iron and steel castings, is planning for the operation of its plant at maximum capacity for the production of battleship armament. It is said that the works will be devoted to this specialty for the next twenty-four months.

WIERTON.—The Phillips Sheet & Tin Plate Company, specializing in the manufacture of cold rolled strip steel and tin plate, is planning for the construction of additions to its plant to increase the present output.

Alaska

CORDOVA.—About 200 mines in the Bonanza and Jumbo Mine, the property of the Kennecott Copper Corporation, have struck for wage increases of from 15 to 50 per cent, depending on market price of copper. About half of the crew is at work.

SEWARD.—The Seward Brick & Tile Company has leased a site in this city and will establish a brick and tile manufacturing plant. Large deposits of the finest pottery clay have been tested and found available.

SEWARD.—The big mill of the Alaska Juneau Mining Company, now operating four units, or about one-third of its maximum capacity, will have all twelve of its units in operation within thirty days About 100 men will be employed.

SEWARD.—William Martin, here, announces that on account of the high cost of cyanide he will not operate the cyanide plant this season, but has installed a centrifugal amalgamator which will remove the gold from the slimes.

British Columbia

FERNIE.—Coke has started to move from the Crow's Nest Pass collieries, and four furnaces of the Grand Forks smelter

of the Granby Consolidated & Mining Company will be blown in shortly. Production is 60 per cent normal, and in the near future 400 tons of coke will be turned out daily from the ovens at Fernie. The two-months strike has been terminated, and most of the men are back at work.

TRAIL.—About 40 tons daily is the average output of the electrolytic zinc smelter of the Consolidated Mining & Smelting Company. The first story of the No. 4 treater plant, requiring 150,000 brick, is practically finished, and steel is being erected.

TRAIL.—The Trail smelter of the Consolidated Mining & Smelter Company, according to a report recently issued, received 3852 tons of ore in the seven days ending June 14, as compared with 2749 tons in the last previous seven days. The mine which made the greatest number of tons shipment to the Trail smelter for the year is the Sullivan Mine at Kimberley, which is unaffected by the coal strike. Its total to date is 61,462 tons. The output is zinc ore, which is treated at the Consolidated company's electrolytic plant at Trail, and requires no coke for smelting.

VANCOUVER.—As a result of the Crow's Nest Pass coal strike, the metalliferous mining industry in the Kootenays is at a standstill, there being at present an extreme shortage of coke.

Manufacturers' Notes

JAPANESE INDUSTRIAL ACTIVITY IN MANCHURIA.—The Government General of Kwantung and the authorities of the Manchuria Railway Company are taking steps to develop industries in the railway zone, and especially in and about Dairen, according to Commerce Reports. They have been making investigations with special reference to the manufacture of oil from Manchurian beans and of soda from Kwantung salt, as well as the zinc-refining and iron-refining industries. The railway company already has acquired the right to exploit a Chinese iron mine, and it is expected that operations will be started before the end of the year. It is now reported that the authorities have nearly completed arrangements for undertaking the soda industry. What shape the project will assume is not yet definitely known, but according to one report, it will be undertaken by the Dai Nippon Engyo Kaisha, which has the sole right of importing Kwantung salt into Japan proper, with the financial assistance of the Manchuria Railway Company. Messrs. Suzuki & Co. and the Mitsui Bussan Kaisha, according to another report a separate joint stock company with $1,985,000 capital will be established for the purpose.

It is understood that the authorities are in communication with Suzuki & Co. and other capitalists interested, and that the project will soon materialize. It will have the advantage over similar undertakings in Japan proper of getting supplies of Kwantung salt at less than 7½ cents per 100 lb., as against 24½ cents paid at home. With this cheap supply of material, it is hoped that the new company will be able to compete with British and German rivals successfully, even after the conclusion of the war.

It is said that a project for the manufacture of bean oil also is maturing. Apart from these official or semi-official undertakings, there have been increased private undertakings for spinning and weaving recently in the zone of the South Manchuria Railway Company.

AMERICAN CHEMICAL COMPANY TO OPERATE IN BRAZIL.—The American Chemical Works (Inc.), with headquarters in Wilmington, Del., has been authorized by the President of Brazil to operate in the Republic, according to Commerce Reports. The capital of the company is said to be $50,000, and the amount set aside for operations in Brazil $10,000.

A. H. NEY, INC., consulting chemists and chemical engineers, have taken over from Moses, Pope & Messer, the chemical laboratories hitherto occupied by the latter at 76½ Pine Street, New York. Mr. J. M. F. Leaper, vice-president of the company, is in charge as director of the laboratory.

THE ASBESTOS PROTECTED METAL COMPANY of Pittsburgh announces the temporary closing of its Cincinnati office on August 1, 1917, due to the fact that Mr. E. G. Irwin, Cincinnati manager, has entered the Ohio national guard. Communications addressed to the home office, First National Bank Building, Pittsburgh, will receive immediate attention.

THE LACKLAND-PAYNE REFRACTORIES COMPANY, composed of Henry K. Lackland and James K. Payne, announced the opening of their office at 1603 Boatmen's Bank Building, St. Louis, Mo. The company is in a position to make prompt shipment of firebrick and clay.

AMERICAN CATALOGUES WANTED. —The American Chamber of Commerce for Italy, located at Via Victor Hugo No. 4, Milan, desires to secure catalogues and price lists from American firms relating to all kinds of goods. This organization, which was formed over two years ago, now has a membership of over 500 and is doing a great work in promoting trade relations between the United States. Recently it has established a trade catalogue library and desires to make it more complete. It is in possession of many catalogues, but desires to secure duplicates for this reason firms that have already sent one copy are requested to send another, and other firms are asked to forward them in duplicate. In addition to the catalogue library the chamber possesses a library containing books on trade information. It solicits contributions in this line also.

BROMINE AND CALCIUM CHLORIDE. —According to figures recently compiled by R. W. Stone, of the United States Geological Survey, the quantity of domestic bromine marketed in the United States in 1916 was 688,260 lb., valued at $922,225. This quantity includes only elemental bromine made from natural brines pumped in Michigan, Ohio, and West Virginia; it does not include bromides, the salts of bromine that are widely used in photography and medicine. The production reported in 1915 was 555,857 lb.

Bromine is used instead of chlorine as an oxidizer in many chemical reactions, and for dissolving gold and separating it from platinum and silver; it is also used in disinfectants, drugs, and photographic chemicals, and in making aniline colors. Recently it has been extensively used in making the asphyxiating gases employed in the European war.

The quantity of calcium chloride made from brine and sold in the United States in 1916 was 26,062 short tons, valued at $216,729, an increase of 22 per cent in quantity and 65.7 per cent in value over the production of 1915. This quantity does not include calcium chloride obtained in the manufacture of soda, as calcium chloride so obtained is not an original constituent of the brine.

Calcium chloride is made from natural brines at Mount Pleasant and Saginaw, Mich.; Pomeroy, Ohio, and Mason, Hartford and Malden, W. Va. As the same brines yield salt and bromine, practically every constituent of them is turned to profit. Calcium chloride is used as the circulating fluid in refrigerating plants, in cement concrete, and in automobile gas-engine radiators to prevent freezing, and for laying dust on roads, drying gases, vegetables, and fruits, and dehydrating organic liquids. Calcium chloride in solution is especially valuable in automatic-sprinkler systems and in fire buckets.

LARGE INCREASE IN SALT USED BY CHEMICAL WORKS.—The domestic consumption of salt in 1916 was 15,720,860 barrels of 280 lb. each, an increase of more than 3,000,000 barrels over the consumption of 1915. According to statistics compiled under the direction of R. W. Stone of the United States Geological Survey, the domestic production of salt in 1916 was 15,449,329 barrels, the imports were 871,992 barrels, and the exports 600,461 barrels. This was an increase of 19 per cent in the quantity of salt produced. The total value of the salt was $13,645,947.

Michigan, as usual, was the largest producer, and New York was a close second. The production, in barrels, by the leading States was as follows: Michigan, 14,918,278; New York, 14,087,750; Ohio, 4,706,193; Kansas, 4,564,793; California, 1,124,236.

Perhaps the most marked feature in the salt industry in 1916 was the great increase in quantity of brine sold as such or used by chemical works, the increase being 37 per cent and the total production over 18,000,000 barrels. The production of rock salt increased over 17 per cent and amounted to 9,973,950 barrels, valued at $2,685,270. On the other hand, the production of evaporated salt increased only 5 per cent, to 17,575,629 barrels, but the value was $10,149,412, an increase of nearly 15 per cent.

FELDSPAR PRODUCED IN 1916.—The production of feldspar in the United States in 1916, as reported to the United States Geological Survey, was 118,465 long tons, having a value as crude material, f.o.b. mines, of $404,689. Of this amount 75,165 long tons entered the market as crude feldspar, valued at $251,372, and 48,496 short tons were ground by the producers and sold for $450,906. During the year the price of crude spar averaged about $3 per long ton and of ground spar about $9.30. Feldspar was mined in the following States, named in order of quantity produced by each: North Carolina, Maine, Maryland, New York, Connecticut, Pennsylvania, Georgia, Virginia, California, New Hampshire, Vermont. The output came chiefly from 50 quarries, but a like number of small or intermittently worked deposits contributed materially to the total.

Feldspar is used mostly in the pottery and enameling industries, which consumed 82 per cent of the year's output. Probably less than 1, 2, and 3 per cent, respectively, of the total output were used for chicken grits, soap, and other abrasive purposes, and in making glass. Roofing and cement surfacing consumed about 7 per cent and an equal proportion was used in preparing fertilizers and in the experimental extraction of potash.

DISTRIBUTION OF ITALIAN SULPHUR SUPPLIES. — An announcement has been made, according to Commerce Reports, by the Minister of Munitions that in connection with the distribution of Sicilian sulphur the Italian Government has allotted certain specified quantities to each of the Allied Governments, and accordingly the British Government will purchase hereafter directly from the Italian Government the quantity allotted to Great Britain. The distribution in England thereupon will be undertaken by the Ministry of Munitions. A committee has been appointed to deal with the matter and it has decided to offer to supply imported sulphur in lots of not less than 5 tons for use in approved trades and industries. The prices per ton for the present will be: Flowers of sulphur, $112; roll brimstone, $102; thirds, $60.83, including delivery to the purchaser's nearest railway station.

From the prices mentioned above a discount of 2½ per cent will be allowed to recognized sulphur merchants and dealers, but not to consumers. Applicants claiming this discount must furnish satisfactory evidence that they were recognized sulphur merchants or dealers before the war.

The committee understands that "recovered" sulphur can be procured, in the ordinary way of business, from the home producers.

Manufacturers' Catalogs

FALKENBURG & LAUCKS, Seattle, Wash., has issued a booklet on "Ore Testing Schedules," dealing with different tests.

THE HOSKINS MANUFACTURING COMPANY, Detroit, Mich., has issued Bulletin 3-A, June, 1917, describing Hoskins pyrometers.

THE ECONOMY FURNACE APPLIANCE COMPANY, Chicago, Ill., has issued a pamphlet on "Stop Making Smoke."

THE LINK-BELT COMPANY, Chicago, Ill., has issued an interesting booklet on "The Ideal Drive for Textile Machinery."

THE GENERAL FILTRATION COMPANY, Inc., Rochester, N. Y., has issued a booklet on "Filtros," describing physical and chemical properties, shapes and sizes, grades, uses, electro-filtros, installations, containers and care of filtros.

SAUVEUR & BOYLSTON, Cambridge, Mass., has issued a pamphlet on "Photomicrographic Apparatus" describing and illustrating their different instruments.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., has issued Bulletin 34-Y on "Gas Gasoline Driven Air Compressor."

THORDARDSON ELECTRIC MANUFACTURING COMPANY has issued sheets on their transformers, wireless and low-voltage, jump spark coils and make and break coils.

D. R. SPERRY & CO., Batavia, Ill., has issued an attractive catalog on the Sperry Filter Press with illustrations.

Other New Publications

SAND-LIME BRICK IN 1916. By Jefferson Middleton. A Department of the Interior publication issued May 31, 1917.

PROPERTIES OF THE CALCIUM SILICATES AND CALCIUM ALUMINATE OCCURRING IN NORMAL PORTLAND CEMENT. By P. H. Bates and A. A. Klein. A Department of Commerce publication No. 78, issued June 9, 1917.

THE VALUE OF PEAT FUEL FOR THE GENERATION OF STEAM. By John Blizard. Issued by the Canadian Department of Mines, Ottawa.

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Profits of the Steel Corporation

Earnings of the steel companies increased through the second quarter of this year and unless production is greatly curtailed by hot weather the earnings in the present quarter will make a new high record. In presenting its report for the second quarter, the United States Steel Corporation deducted an allowance for the excess profits tax on the basis of the House bill as reported to the Senate July 3. It is correct, of course, to deduct taxes before reporting earnings, but at the same time this particular tax is upon profits. The first quarter earnings had been reported without deduction, of course, but the estimated amount for the first quarter is deducted from the surplus previously reported for the quarter. To harmonize the reports for the two quarters the figures may be presented thus:

	First quarter.	Second quarter.
Total profits	$113,121,012	$144,498,076
Excess profits tax	33,863,000	53,918,872
Earnings remaining	$79,258,012	$90,579,204

The excess profits tax thus computed is not particularly onerous, even though it represented 30 per cent of the total profits in the first quarter and in the second quarter 37 per cent. The second quarter earnings, even with the tax deducted, were at the rate of $362,000,000 a year, whereas the earnings in 1916 were $333,574,178, and the earnings in the best preceding year, 1907, were $160,964,674.

Since the latter part of 1915 the tonnage output of the Steel Corporation has not varied greatly. There has been an increase on account of new plant capacity, but not as large an increase as occurred in the case of the independents. Last winter, output was materially restricted on account of traffic congestion on the railroads which persisted even to the second quarter of this year. The earnings were about $17,000,000 per month in the last quarter of 1915, and they amounted to about $50,000,000 last June, without allowance for the excess profits tax. By far the major part of the increase in earnings has been due to higher prices realized on the shipments. These increases followed advances in the open market by a period of from six to nine months, as the corporation has been sold well ahead. Last December, January and February the earnings were less than in the preceding November, this being due to restricted production, coupled with the fact that from May to July inclusive, the steel market had not advanced materially. Beginning with last March there have again been large increases continued in monthly earnings. The June shipments were chiefly against sales made last November, as an average period, and as the corporation's prices

continued to advance until the latter part of April further increases in earnings per ton are to be expected. The corporation did not participate in the advances made by independent mills in May and June.

The utterly fictitious character of the finished steel market as lately quoted is brought out by some simple comparisons. The June shipments were about 1,250,000 gross tons, while the total profits were $50,000,000. There is good ground for estimating that the average invoice price of the shipments was at least $60 a ton less than the lowest prices now quoted as "the market": 4½ cents for bars and shapes, 8 or 9 cents for sheets, 9 or 10 cents for plates, and so on. Were such prices realized the profits would be $100 per ton instead of $40 and a month's total profits would be $125,000,000, equal to $1,500,000,000 for a year. As the corporation, at present, is less than a 50 per cent interest, the steel industry's total profits would be considerably in excess of three billions a year, or about three billions greater than the average profits in the three years preceding the war. Serious question has been raised whether a much less amount than this could be raised in war taxes without greatly disturbing business. If there is question whether all the industries of the country together cannot pay two billions without having their activities impaired, it is quite certain that one class, the consumers of steel, could not possibly pay an extra three billion to the producers of steel.

No doubt the steel producers realize this fact perfectly. They have shown no disposition to point it out, and two reasons for the reticence may be assigned. First, they would like to see the business run along with consumers paying higher and higher prices until something breaks of its own accord. Second, they have been fearful of the Government exacting from them prices so low that nothing like a reasonable profit would remain. For this fear certain persons in position of more or less authority have given good ground, for repeatedly they have spoken of "cost plus 10 per cent" which is absurd in the case of steel, because in the case of an integrated concern, meaning 75 to 85 per cent of all the production, the capital is turned over, at full operation, once in from two and a half to three years, so that 10 per cent on the cost of production is from 3 to 4 per cent on the investment, with no allowance for depreciation and exhaustion allowances.

The Steel Corporation realized the danger of the situation when last April it ceased advancing its prices. Its last official prices average fully $30 a ton lower than the prices now quoted as the market, while its realized prices in June were as much below its quotations.

A readjustment in steel prices is about to occur, whereby a level will be reached at which business can be conducted, and it will readily be observed that very great reductions from the present fictitious quotations can occur without pushing earnings of steel producers below an extremely satisfactory level. In the meantime, buying by private consumers and the allied governments has been almost entirely held up, awaiting some stability in prices before making future commitments.

The Handwriting on the Wall

Commodity prices are up, away up beyond that warranted by the present wage scale; either the wages must go up, or the prices come down to a more equitable ratio—a disastrous explosion of domestic disorders will unquestionably follow a maintenance of the present status. It may be accepted without argument that prices, taken by and large, are too high. Even thoughtful manufacturers have been moved to restrain if possible the unconscionable antics of the soaring markets by urging caution, knowing the truth in the old song, "Never birdie flew so high she didn't have to light." And in that "lighting" is the rub—for prices have been so top heavy that a readjustment is absolutely necessary, and yet the danger of a crash is imminent. One of the most pressing problems before the American government, manufacturer and common citizen, is therefore the ways and means of getting the prices of raw materials and finished products down to reasonable levels, and that safely.

Individual effort on the part of isolated manufacturers of unusual public spirit will not affect the desired result, for his patriotic differential would be meat for the middleman, as long as other producers demanded and could get a higher price for the same material.

On the other hand, a representation from the producers meeting and agreeing upon a "fair and equitable" price would be little more successful. On the face of it, this seems to savor much of illegal combinations for fixing prices, and is very liable to all the ills of monopolistic control. A glowing example of the way this scheme would work is before our eyes from the conference of bituminous coal operators. Here a standard price of three dollars a ton at the mouth of the mine was promulgated, a price promptly denounced as exorbitant by a cabinet member, and frankly acknowledged by the coal trade to be so good as to allow them a very fattening income to make up for "lean" years in the past. Even though the scheme would work better with other more patriotic and more centralized industries, such as aluminium, the difficulties grow apace with decentralized, poorly organized producers, such as, for instance, fertilizers.

If only the Government were concerned, if it were the only buyer of a certain commodity, an "excess-profits tax" would in effect lower prices to a reasonable figure. England, for instance, through her Ministry of Munitions, controls essential industries, both as to their labor conditions and their profits, the latter being generally limited to 120 per cent of the average before the war, any excess going to the government. Should the Government be the only consumer it would be entirely indifferent what price might be charged, since all excess returns as taxes. What boots it, however, to ruin less fortunate corporations and individuals through extortionate prices for necessities, in order that a larger excess-profits tax might go into the national treasury? Even though the outsider survive, the arrangement savors much of hateful taxation without representation; furthermore the principle of "one price to all" is lost.

A further suggestion advanced by paternalists is that the Government bodily take over and operate certain basic industries. This scheme is too un-American to receive much consideration. Or rather, the American public is so familiar with the uneconomical and graft-ridden administration of certain public undertakings, that they have a suspicion that such hastily devised governmental operation would be quite likely to defeat its own ends. American industry is so delicately interrelated and depends so much upon the directing force of innumerable keen masters to run along of its own inertia after the operating minds are removed and replaced by well-meaning but less competent bureaucrats.

If one were willing to accept the hackneyed excuse of the profiteer—the overworked "law of supply and demand"—he might think that the best way to reduce prices was to reduce the demand, that is, to curtail consumption. If the entire consuming public could be reached and convinced and induced to reduce its consumption, the demand for a certain commodity, or for all commodities, for that matter, might be reduced to such a point that one cause for high prices would be eliminated. To state this possibility is but to realize its impossibility. Yet in some such manner must and will the prices of munitions to the Government be reduced. And if we mistake not, the tools are already in the hands of the Government, and the Government is proceeding to use them. It now behooves the industries to read the auguries, and direct their steps accordingly.

The twins "supply and demand" are hybrid; the terms are not of the same order. The expressions "supply and requirement" and "offering and demand" are of the same order. The former is material, the latter is mental. "Demand" is what people ask for, "offering" too often is the bluff of the producer; "supplies" are really the material on hand to sell, and "requirements" represent the real needs of the consumers. Prices can evidently be raised by a large demand and small offering as readily, or even more readily, than by a long requirement and a short supply; the danger one can not see is the worst feared. In fact the producer is now busy explaining that present prices are really fictitious in that they cover a low volume of sales forced to that level by the demand of excited consumers whose immediate requirements had not been contracted for months ago.

Yet if prices can be boosted by a commercial poker game, they certainly can be lowered by like mental processes. Witness the stagnation of business and the abrupt halt in price ascension immediately following the President's statement about "Patriotism and Profits," and his proclamation of adherence to the "One Price to All" principle. The requirements still exist; yet the demand has vanished.

Now comes the War Industries Board and their Central Purchasing Commission with advisory power over all army and navy contracts. These committees are composed of men who know their business, who have been in touch with big business long enough to be informed of the total production of any one commodity, to remember the prices which a year or two ago were returning a very fair profit to the manufacturers, and to understand the effect which altered conditions and wage advances should have upon these prices. They also have at their disposal correct information as to the exact figures the allied governments are paying for their munitions, both at home in "controlled" industries, and abroad on contracts. With this combined experience, knowledge and data, the War Industries Board will call into conference with it committees of producers of munitions—steel, alcohol, gasoline, motor trucks, copper, what you will—and say to this committee of manufacturers, "We want fifty per cent of your output of ship plates, we will pay 2½ cents a pound on account, and hold the exact price in abeyance pending investigation of the actual costs by the Federal Trade Commission."

Then the American manufacturer can do two things. He can either accept the offer of the business, gracefully and patriotically, or he can refuse. But on second thought, can he refuse, short of shutting down his plant? For suppose he elects to refuse the Government business and attempts to renew business on the present basis of maybe 6, hopefully 10 cents per pound. Who else but the Government is buying ship plates just now, what with the activities of the Shipping Board in laying down new construction and commandeering ships on the ways? And would England wish to buy ship plates from America at maybe 6, hopefully 10 cents a pound, when she can get them at home for 2½ cents? Or where would the steel man get bottoms to ship his metal even though he find a neutral market? After surmounting these difficulties, who would lift the embargo on plates from his suffering shoulders? Or does he delude himself into thinking the independent structural steel fabricators or tank and boiler makers are coming to his rescue for any higher price than the "one price to all" assured by the President?

The consumer views the situation with equanimity. The psychological aspect is pregnant with power: the demand is sentimentally lacking; the material aspect is overbearing in its weight: the requirements are artificially limited. The price is bound to come down, and the manufacturer should steer his course accordingly, and at once, thankful that he is assured of a just price, "a price which will sustain the industries concerned in a high state of efficiency, provide a living for those who conduct them, enable them to pay good wages, and make possible expansion of their enterprises which will from time to time become necessary as the stupendous undertakings of this great war develop." Where could he find extenuating circumstances to justify more liberal treatment from consumers, at last with the whip hand?

Of course the war industries board has advisory capacity over Government purchases only. But private enterprise can wait for a price adjustment—absolutely nothing *must* be done to-day excepting that which is necessary for the war. Then too, the illustration is taken from a certain branch of the steel industry because its control has been best accomplished at the present day. For ship plates merely substitute TNT, tungsten, pyrite, or what not.

Readers' Views and Comments

The Sulphuric Acid Treatment of Gasoline

To the Editor of Metallurgical & Chemical Engineering

In these critical times when practically the whole world is one vast battle ground, every conserving influence for the preservation of food, steel, ships, or petroleum, is of importance.

In a warning given at Washington on May 25, 1917, Mr. Van H. Manning, director of the Bureau of Mines, stated that:

> One of the serious problems confronting the United States at this time is the production and consumption of petroleum and gasoline in the United States. The situation is serious, and it is my purpose to give you a few of the essential facts and allow you to draw your own conclusions as to the remedies that ought to be applied. As a nation, we are wasteful, apathetic and forgetful. We waste our natural resources with shameful prodigality, we are apathetic of the future.

On July 22, 1917, Mr. A. C. Bedford, president of the Standard Oil Company of New Jersey, and chairman of the committee on petroleum of the Advisory Commission of the Council of National Defense, stated:

> If our government is to have the petroleum it will need to prosecute the war successfully, and supply all necessities directly growing out of the war, two steps will have to be taken, namely:
>
> 1. The public will have to economize in the use of gasoline. Sufficient gasoline should be available to provide for the normal uses of automobiles. But pleasure riding should be curtailed. People should look upon their automobiles as necessities to be used only when needed. Not a gallon of gasoline should be used in the present emergency except for some useful end.
>
> 2. Every oil producer in the country should be encouraged as a patriotic effort to secure the utmost possible output of crude oil.

It is the purpose of this note to indicate that 700,000 barrels (in round numbers, 30,000,000 gal. of gasoline) could be saved in the refinery by eliminating the sulphuric acid, caustic soda, and washing treatment—in short, by marketing the gasoline direct from the steam stills.

The Federal Trade Commission's "Report on the Price of Gasoline in 1915," contains the following data:

Year	All Gasoline Engines, Total Horsepower	Per Cent Increase	Gallons Gasoline Sold by All Refiners	Per Cent Increase
1913	11,279,143		1,099,350,000	
1914	13,887,331	23	1,331,230,000	21.09
1915	22,524,858	62	1,849,790,000	38.95

The above table clearly indicates the greater increase in the percentage of gasoline-engine horsepower in comparison to the percentage increase in gasoline production. From 1913 to 1915 the total horsepower doubled and it is reasonable to believe that from 1915 to 1917, the increase will be quite as much. Since this increase seems to be assured, it is absolutely vital to this country that every gallon of gasoline be conserved, not alone on the ground of sound economics, but for the larger issues involved in this war. For the motor car and motor truck on the various battle fronts are the very arteries linking supplies and hospitals with the fighting men.

It has been estimated that in the year 1917, 70,000,000 barrels, or 3,000,000,000 gal. of gasoline will be marketed by the various refiners. In the refining of one barrel of gasoline average practice would show the use of at least 1 lb. of 66-Be sulphuric acid, with 0.1 lb. of caustic soda, and approximately ¾ of a barrel of water for washing. This entails a loss of *at least* 1 *per cent* of gasoline due to treatment with sulphuric acid, caustic soda, and washing. Of course, it is recognized that if benzine is treated with acid (which is the practice in a number of plants) that there may be a slight variant from the above figures, but even then the loss would be well within the above figure of 1 per cent.

Tabulating the above values in terms of actual gallons and tons of material involved on the estimated amount of 70,000,000 barrels, or 3,000,000,000 gal. of gasoline to be marketed in 1917, there would result:

Loss of gasoline due to sulphuric acid treatment	700,000 bbl.	30,000,000 gal.
Tons of sulphuric acid used to treat 70,000,000 bbl. of gasoline	35,000 tons	
Tons of caustic soda used to treat 70,000,000 bbl. of gasoline	3,500 tons	
Water used in treating 70,000,000 bbl. of gasoline	52,500,000 bbl.	2,205,000,000 gal.

The above table excludes the costs of equipment and of handling the large quantities of material involved. The total cost of acid treatment adds considerably to the cost of gasoline per gallon, which is naturally shouldered by the consumer, giving him a highly questionable return in "better product" for the difference in cost.

The acid treatment of gasoline adds very little, *if anything*, to the value of the resulting product. The acid treatment removes unsaturated hydrocarbons from the gasoline, which hydrocarbons have a greater driving power in a motor than saturated or paraffine hydrocarbons. Moreover, the specification of a water-white gasoline as one of the tests of its fitness is much overrating its value to the gasoline.

There are no valid objections to the use of a gasoline with a tinge of color or so-called odor in it. Take as an example a cracked gasoline with a tinge of yellow in it. Refining with sulphuric acid to rid the gasoline of the tinge of yellow or slight odor does not add anything to the gasoline as a motor fuel. In short what valid objections are there to the use of a gasoline with a slight odor or a tinge of yellow or red as in the case of some cracked California gasolines?

In view of the above data as to the conservation of 30,000,000 gal. of gasoline, it seems advisable to the writer, not alone to conserve the gasoline but also the sulphuric acid, caustic soda, water treatment, equipment, and man power used in the unnecessary refining of gasoline as conducted to-day. The minimum saving in economic wealth would be $10,000,000.

Gustav Egloff.

Methyl Alcohol and Acetone as By-Products of the Soda Pulp Industry

To the Editor of Metallurgical & Chemical Engineering

SIR:—With reference to our communication produced on page 416 of your edition of April 15, 1917, we note that we have in error transposed the quantities of methyl alcohol, and acetone, higher ketones and aldehydes, respectively. The "Spirit Test," second line on page 417, first column, should read as follows:

Spirit test: 30 per cent methyl alcohol, and 70 per cent acetone, ketones and aldehydes.

BLAIR, CAMPBELL & MCLEAN, LTD.

GLASGOW, SCOTLAND.

An Independent Company

To the Editor of Metallurgical & Chemical Engineering

SIR:—Permit me to correct an erroneous statement which appeared on page 150 of your number of Aug. 1, 1917, concerning the General Bakelite Company of which I am president. The General Bakelite Company, contrary to your statement is not a subsidiary of the Roessler & Hasslacher Chemical Company nor of any other company.

L. H. BAEKELAND.

GENERAL BAKELITE CO., NEW YORK CITY.

Soldiers, Attention!

Keep Us Informed of Your Enrollment

A regular supply of reading matter will go a long way in relieving many dull and tedious hours necessarily endured by the men and officers of the National Army, cut off from home ties and usual occupations. Each technical man in service will bless the existence of his magazines on their arrival, hailing them even as an old and tried friend. To that end the subscribers of METALLURGICAL AND CHEMICAL ENGINEERING are urged to keep the subscription department constantly and correctly informed by postal card of his company, regiment and corps, in which case every effort possible will be made at this end to see that he receives his paper promptly.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15.

National Safety Council, New York, Sept. 10-15, 1917.

National Exposition of Safety and Sanitation, New York, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 24-29, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

Technical Association of the Pulp and Paper Industry.—Joint meeting with the Technical Section of the Canadian Pulp and Paper Association, Holyoke, Mass., Sept. 27 to 29, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Western Metallurgical Field

Labor Troubles Curtail Copper Production

The output of copper of the United States has been seriously curtailed as a result of a long train of labor troubles in the Rocky Mountain region. During the last month strikes of greater or less extent have multiplied in various mining camps from Alaska to Arizona;—in some places the difficulty of wages was no sooner adjusted than another strike against camp living conditions was declared. Kennecott, Butte, Globe-Miami, Clifton-Morenci, and Bisbee all have been practically shut down. In most of these places the Industrial Workers of the World,—or more properly known from their initials, the "I Won't Work"—were very active in fomenting the strikes, often openly avowing a purpose of handicapping the Government by crippling the copper producing industry. The situation was further aggravated by feuds between the I. W. W. and the International Union of Mine, Mill and Smelter Workers, headed by Charles H. Moyer, until it was impossible to find out just what the trouble was about, and what body of men should be approached with negotiations. The impossibility of any patriotic appeal to these men is evident from the fact that nearly half of the employees of the copper mines in some States are aliens, working here only to "make a stake."

Under such circumstances the demands made by many strikers were merely "hold-ups," and it is only a question of a short time when an ignorant, unskilled laborer now dissatisfied with $5 a day and striking for $6, will be striking for $7 if he is given the present demand. In nearly all instances the present pay is based upon a sliding scale depending upon the price of copper, and consequently is now two-thirds greater than it was before the war.

In nearly all cases a settlement of the troubles has been made or is well under way, leading to an increase of wages of some amount up to about 50 cents a day. In the meantime exciting events, bloodshed, murder and treason have occurred. At Bisbee, after a double killing, a citizens' committee aided by deputy sheriffs loaded over a thousand I. W. W. members and sympathizers, both residents and floaters, into freight cars and escorted the train over the border into New Mexico, where the exported men were taken into custody by the Federal troops. At Butte a new scale at about 25 cents a day increase was adopted by the operators, and a reformation in the obnoxious "rustling-card" system instituted. Squabbles between various metal-worker unions prevent any general settlement, although the Federal mediator, W. H. Rodgers, has been able to conclude terms with most of the belligerents. The small hold of the I. W. W. on that community is evident from the comparative quiet following the lynching of one of their most violent agitators. In the meantime, however, hundreds of experienced miners have left the district rather than become involved in the trouble, and the scarcity of labor has thus been greatly accentuated.

The Leadville Strike

Unlike most of the strikes in the West, the Leadville strike was not an outcome of I. W. W. activities. It was simply a universal demand of the strikers for a raise in pay, based on the idea that with the present prices of metals the operators are making a greater

profit, and no attempt was being made on the part of the operators to raise the wages of the miners to balance the increased cost of living.

The minimum wages paid prior to the strike was $3.50 per day. Several of the mines operating in the district used a sliding scale for wages based on the value of the individual, but still holding the minimum rate as stated above. In this manner daily wages as high as $5.50 were paid to some of the laborers.

Within the past two years the wage scale of the district has been raised 16 2/3 per cent, that is, the minimum was raised from $3 per day to $3.50. The present demand of the miners was for an increase of $1 over the $3.50 per day. To this the mine operators objected, claiming that the profit made per ton of ore on such a basis would be so low that it would not pay to operate in the district. Leadville is a low-grade silver, lead, zinc camp and with the increase in cost of materials essential for mining operations, it would then be practically impossible to work the district profitably.

The situation was investigated by the State Industrial Relations Commission of Colorado, whose final findings were that the miners were not justified in their demands. It was found by the commission that the rents had not been increased for the past ten years. Food, clothing, shoes and other materials essential for the up-keep of the families of the miners had increased in the same proportion as the same goods had increased in Denver. Board had increased $5 per month due to the increased cost of food. On the other hand, the operators were found not to receive anything like the full benefit of the increase in metal prices, due to the existence of old contracts and unequitable smelter schedules.

The mine operators then offered an increase of 50 cents per day to the minimum wages paid. This the miners refused to accept and all mediation on part of the governor and the commission seemed of no avail, but after a three-days session between the mine operators and the representatives of the labor faction it was decided that operations at Leadville be resumed on Aug. 2 based on the 50 cents per day increase.

The settlement of the trouble was made more difficult by the refusal of the mine-operators to treat with delegates of the union, feeling that it would only be an entering wedge for the same element whose domination terminated in a bloody struggle several years ago. The present union has enrolled far less than half of the miners of the district, and a bare majority of their membership voted the strike. This faction is generally thought to be the Austrian element in the union, and the strike was quite unpopular among the American miners.

Midyear Spelter Report.—The United States Geological Survey, from returns representing 99 per cent of the output, estimates that the production of spelter during the first six months of 1917 was 364,000 short tons, as compared with 351,000 short tons during the last half of 1916. Stocks on hand are estimated at 33,000 tons as compared with 17,600 at the beginning of the year. A large number of retorts, about 35,000, including fourteen complete plants, were reported idle June 30, in addition to the retorts engaged in refining prime western metal and in redistilling zinc ashes.

Fuel Oil Situation Growing Serious in West

A report has just been completed by the committee recently appointed by Governor Stephens of California to make an investigation of the petroleum resources of that state, with particular regard to the industrial and military needs of state and nation in the present war emergency. The substance of the report was published in the *Engineering News-Record* Aug. 9, 1917.

The committee found that the oil production in California (whence comes one-third the entire supply of the United States and about one-quarter of the world's supply) is falling behind consumption at the rate of 35,860 bbl. per day. This excess of consumption over production is now being taken from oil in storage, and at the present rate the storage in California will be reduced to the 10,000,000-bbl. safety margin by Sept. 20, 1918. Should consumption increase or production decrease, both of which are likely unless immediate action is taken, the safety margin will be reached at an earlier date.

The seriousness of the situation is emphasized by the fact that considerable time is required to adapt power equipment for other sources of energy. It is pointed out in the report that fuel oil is largely used in the operation of the steam railroads of the Western States, the Panama Canal, steamship lines, cement plants, mines and smelters, gas plants, sugar refineries and, in general, a substantial portion of the manufacturing, industrial and agricultural enterprises of the Western States.

CONSUMPTION EXCEEDS PRODUCTION

The oil production in California has not been increasing in recent years. In 1914 it was 103,620,000 bbl.; in 1915 it was 89,570,000 bbl.; and in 1916 it was 91,820,000 bbl. The production in 1917, indicated by the present conditions, would be about the same as last year. The report points out, moreover, that further substantial increases in the annual petroleum production cannot be expected through the discovery of new fields or large extensions of existing fields.

Throughout 1916 the consumption exceeded the production by an average of 1,100,000 bbl. per month, or 36,650 bbl. per day. During the first five months of 1917, consumption exceeded production by 5,415,000 bbl., or 35,860 bbl. per day. Of course, the storage has been reduced correspondingly. Although the total remaining storage on July 1, 1917, is reported to have been about 38,000,000 bbl., this would be reduced to a much lower figure if limited to available fuel oil, because a considerable percentage is light oil, is below tank outlets or is otherwise unavailable. The stored oil is owned principally by the Standard and Union oil companies.

The substitution of coal for fuel oil was considered in the investigation, and the conversion of steam railroads from oil to coal burners in regions adjacent to coal fields is touched upon in the report. However, apart from the changes already made or contemplated, there is little possibility of further conversion from oil to coal during the war, unless the conditions surrounding the production and transportation of coal materially change.

The substitution of hydroelectric energy has already taken place to a considerable extent in industrial and

agricultural uses, but this has been hampered by difficulty in securing copper and other material and also by the disturbance of existing conditions that would be entailed by diverting large blocks of hydroelectric energy to service previously rendered by oil-burning plants. Large additional oil saving through the substitution of hydroelectric energy cannot be expected during the war, the report states; but after the war and the restoration of normal industrial conditions, wherever hydroelectric energy is available it will play an increasingly important part as a substitute for the fuel. Meantime, interconnecting the transmission systems of electric companies is suggested as a means of eliminating or at least reducing the necessity of maintaining steam-electric plants.

RELIEF MEASURES

The difficulties standing in the way of prompt and substantial increase of production must be quickly removed, the report states, if a serious industrial crisis is to be forestalled. The emergency cannot be met without the assistance of the Federal Government, and the report urged that California state officials make direct appeal to the administration at Washington.

While it is believed possible to increase production more than 30,000 bbl. per day, this increase cannot reasonably be expected to be available before June 1, 1918. To secure the best and most immediate results the committee recommends:

1. That production be increased immediately, by additional drilling on the lands which can be developed in the least time with the smallest expenditure of material and labor.

2. That every effort be made to reduce field losses, to encourage the highest use of petroleum and its products and the substitution of other forms of fuel or power where possible.

3. That the Federal Government be promptly advised of the situation and asked to render every assistance possible.

4. That manufacturers of oil-well supplies and the railroads be directed to expedite the production and transportation of oil-well casing, drill stems, wire cables and similar material—bringing the influence of the Federal Government to bear, if necessary.

5. That all skilled workmen in the oil fields be exempted from military service.

6. That lands in litigation be developed either through the Federal receivers or through the claimants to the lands, with due regard to the rights of all parties. (In this connection it is notable that 70 per cent of the desirable undrilled lands are involved in litigation with the Federal Government.)

7. That additional lands be thrown open for development by the Federal Government.

8. That steps be taken immediately to correlate the transportation facilities of the railroad, steamship, oil-pipe and oil companies, that transportation may be expedited, and

9. That as far as possible the burning of unrefined petroleum be prohibited.

The committee, which is officially known as the Committee on Petroleum of the State Council of Defense, consists of Max Thelen, president of the California Railroad Commission; Eliot Blackwelder, professor of geology, University of Illinois; and David M. Folsom, professor of mining engineering, Leland Stanford, Jr., University. The preliminary outline of the committee's report was telegraphed to Washington on July 7 by Governor Stephens, and a prompt acknowledgment was received by wire signed by President Wilson, expressing appreciation of the importance of the work and promising Federal support for the general plan.

Boston Meeting of American Institute of Metals

The following tentative program of papers has been prepared for presentation at the meeting of the American Institute of Metals to be held in Boston, Sept. 25 to 28, 1917:

Crucibles and Furnaces:

"The Crucible Situation," by Prof. A. V. Bleininger, Bureau of Standards, Pittsburgh, Pa.
"Melting Yellow Brass in New Form of Induction Furnace," by G. H. Clamer, Ajax Metal Co., Philadelphia, Pa.
"The Crucible Situation," by M. McNaughton, Jos. Dixon Crucible Co., Jersey City, N. J.
"The Electric Furnace & Non-Ferrous Metals," by Dwight D. Miller, The Society for Electrical Development, New York City.
"My Experience with Metal Melting Furnaces," by W. H. Parry, National Meter Co., Brooklyn, N. Y.

Melting and Casting Non-Ferrous Metals:

"Casting Bearings in Sand & Metal Molds," by R. R. Clarke, Pittsburgh, Pa.
"The School End of the Job in Training Foundrymen," by C. B. Connelley, Dean, Carnegie Institute of Technology, Pittsburgh, Pa.
"The Flux & Cleaner Question of Brass," by E. A. Frohman, S. Obermayer Co., Pittsburgh, Pa.
"Negative Experiments on Waste Core Sand," by Dr. H. W. Gillett, Bureau of Mines, Ithaca, N. Y.
"Pyrometers—Their Construction & Application," by John P. Goheen, Brown Instrument Co., Philadelphia, Pa.
"Surface Tension & Deoxidizing of Metals," by W. J. Knox, Metals Deoxidizing & Refining Co., New York City.
"The Briquetting of Non-Ferrous Light Metal Scrap," by A. L. Stillman, General Briquetting Co., New York City.
"The Swelling of Zinc Base Die Castings," by H. M. Williams, National Cash Register Co., Dayton, Ohio.

Munitions, Etc.:

"The Present Status of Tin Fusible Plug Manufacture & Properties," by Dr. Geo. K. Burgess, and Gurovich, Bureau of Standards, Washington, D. C.
"Stellite," by Elwood Haynes, Haynes Stellite Works, Kokomo, Ind.
"Fire Prevention in Large Industrial Establishments," by C. W. Johnson, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
"The Use of Die Casting in Munitions," by Chas. Pack, Doehler Die Casting Co., Brooklyn, N. Y.
"A Few Points on Alloy Patents," by Wm. J. Rich, Patent Office, Washington, D. C.
"Shrapnel Bullets," by Harold J. Roast, The Jas. Robertson Co., Ltd., Montreal, P. Q.
"Recent Industrial Uses of Aluminum," by F. G. Shull, Aluminum Co. of America, Boston, Mass.

Testing Non-Ferrous Metals:

"Some Comparative Tests on Test Bars and Actual Castings," by W. M. Corse (The Titanium Alloy Mfg. Co., Niagara Falls, N. Y.), Buffalo, N. Y.
"Analysis of Babbitts & Brasses," by E. W. Hagmaier, Buffalo, N. Y.
"Standard Test Bars of 88-10-2 and 88-8-4, being the result of co-operative work of six foundries; a new series of tests," by C. P. Karr, Bureau of Standards, Washington, D. C.
"The Expansion Coefficients of Alpha and Beta Brass" and "The Corrosion of Manganese Bronze under Stress," by Dr. Paul D. Meriea, Bureau of Standards, Washington, D. C.
"Corrosion of Brasses of the Muntz Metal Type," by H. S. Rawdon, Bureau of Standards, Washington, D. C.

"The Analysis for Cadmium in Brass," by Dr. F. Schramm, Bureau of Standards, Washington, D. C.

Metallurgy and Metallography:

"The Electrolytic Production of Antimony," by Prof. D. J. Demorest, The Ohio State University, Columbus, Ohio.
"The Electrical Properties of Some High Resistance Alloys," by Prof. M. A. Hunter, Rensselaer Polytechnic Institute, Troy, N. Y., and F. M. Sebast.
"The Amorphous Theory in Metals," by Prof. Zay Jeffries, Case School of Applied Science, Cleveland, Ohio.
"The Uses and Metallurgy of Antimony," by K. C. Li, Wah Chang Mining & Smelting Co., Inc., New York City.
"Development and Reabsorption of the Beta Constituent in Alloys which are normally of the Alpha Type," by Prof. C. H. Mathewson, Dept. of Mining and Metallurgy, Yale University, New Haven, Conn., and Philip Davidson.

Great Interest in Coming Chemical Industries Exposition

The exposition management reports that manufacturers, works managers, chemists and engineers all over the country are taking a very active interest in the Third National Exposition of Chemical Industries to be held in the Grand Central Palace, New York, week of Sept. 24, 1917. Numerous letters from men all over the American continent and from foreign countries as well, have been received at the Exposition offices.

The success of the former expositions have been heralded in European countries. This has stimulated these countries to seek a better knowledge of the remarkable growth of the American chemical industries.

While refraining from giving information on the nature of their exhibits, the information on hand shows that there will be a very great many in operation—not only to demonstrate what certain machines will perform but operations upon actual material showing actual manufacturing processes in many of the industries.

Exhibits from railroad companies, state, and land companies showing the natural resources available in their several sections for the chemical industries will be made. Not only will these exhibits show the resources in their natural state but in many cases, where such have been made, the samples of the finished materials they produce.

The U. S. Government through the Bureau of Soils will be represented and will have an exhibit illustrating the fertilizer situation, and more especially American sources of potash.

The program of the exposition published in part in the last issue bids fair to attract much attention. In one phase it will discuss the foreign trade opportunities that the American manufacturer now has presented to him, and how to gain and hold those markets. Another phase of the program covers the work of some of the war councils. It will be remembered that at the First Exposition Mr. Howard Gross was one of the speakers and there proposed a Governmental Tariff Commission. The appointment of that committee by the President is but of recent moment and it is an interesting thing to learn how that committee will operate. Dr. Grinnell Jones of Harvard University, who has been selected as chemist to the commission, will be one of the speakers. It is not unlikely that Dr. F. W. Taussig, the chairman of the commission, will be another speaker to enter into the national operation of the commission for all the industries, while Dr. Jones' discussion will be confined to the chemical phases of the commission's work. It is undoubted that these addresses will be of great importance to the chemical industries, supplying them with much valuable information as to what they may expect, and as to how they could assist the commission making its work more thorough, to have a stimulating effect upon the productiveness of the American chemical industry.

There will be a symposium upon the national resources at which men thoroughly familiar with them will discuss the great existing opportunities.

Tentative Program

Monday, Sept. 24.—Opening day.
- Opening addresses by Dr. C. H. Herty, Dr. Julius Stieglitz, President American Chemical Society; Dr. C. G. Fink, President American Electrochemical Society; Dr. G. W. Thompson, President American Institute of Chemical Engineers.

Tuesday, Sept. 25:
- Prof. M. T. Bogert, Chairman, Chemical Committee, National Research Council, "The Operation and Work of the National Research Council for the National Weal."
- Dr. Grinnell Jones, "The Tariff Commission and Its Operation with Reference to the Chemical Schedule."

Wednesday, Sept. 26:
- W. S. Kies, Vice-President National City Bank, "The Development of Export Trade with South America."
- Dr. L. H. Baekeland, Naval Consulting Board, "The Future of the American Chemical Industry."
- Meeting of the Technical Association of Pulp and Paper Industry.

Thursday, Sept. 27:
- Symposium on National Resources for Chemical and Allied Industries, participated in by:
  - Mr. C. H. Crawford, Assistant to President of Nashville, Chattanooga & St. Louis Railway.
  - Mr. V. V. Kelsey, Chemist-Industrial Agent, Carolina, Clinchfield & Ohio Railway.
  - Dr. E. A. Schubert, Mineralogist-Geologist, Norfolk & Western Railway.
  - Dr. T. P. Maynard, Mineralogist-Geologist, Central of Georgia Railway & Atlantic Coast Line Railway.
  - Dr. J. H. Watkins, Geologist, Southern Railway.
- Meeting of the American Institute of Chemical Engineers.

Friday, Sept. 28:
- Meeting American Chemical Society, New York Section.
- Papers to be announced later.

The motion picture program will be announced later, though the following firms have placed their films at the use of the exposition managers: The American Cyanamid Company, Barber Asphalt Paving Company, E. I. DuPont de Nemours & Company, General Electric Company, Eagle-Picher Lead Company.

Production of Coal in 1916.—Statistics compiled by the Geological Survey show the total production of coal in the U. S. in 1916 to have been 590,098,175 net tons as compared with 531,619,487 tons in 1915. The number of employees was 14,000 less in 1916, but the number of working days was 26 greater.

The Principles of Filtration—II

By D R. Sperry

In a previous contribution* the fundamental law of filtration was deduced and found to be:

$$Q = \sqrt{\frac{2PKT}{R\%}+\left(\frac{KR_m}{R\%}\right)^2} - \frac{KR_m}{R\%}$$

In which:

P = Pressure.
T = Time of filtering.
K = Rate of deposition.
R = Resistance of the solids.
$\%$ = Per cent of solids in the mixture.
R_m = Resistance of filter base.

Another factor to take care of the effect of temperature was deduced and it was stated that two other factors might be added to allow for the effects of the squeezing together of non-rigid solids under increased pressure and to take care of the effects of gravity through the agency of settling or sedimentation.

The purpose of this article is to verify the fundamental equation of filtration by an analysis of actual time-discharge curves from a filter.

DERIVATION OF NECESSARY MATHEMATICAL TOOLS

Before it is possible to analyze a time-discharge curve from a filter a simple mathematical discussion is necessary.

Let us take the fundamental equation and simplify it by putting:

$$\frac{2K}{R\%} = W$$

and

$$\frac{KR_m}{R\%} = N$$

The fundamental equation then becomes:

$$Q = \sqrt{WPT + N^2} - N$$

If we take a time-discharge curve from a filter and select two points thereon such as (A) and (B) in Fig. 7, whose respective locations are T, Q and T_1Q_1 we know that

$$Q = \sqrt{WPT + N^2} - N$$

and

$$Q = \sqrt{WPT_1 + N^2} - N$$

Squaring each of these equations:

$$Q^2 + 2NQ + N^2 = WPT + N^2$$
$$Q_1^2 + 2NQ_1 + N^2 = WPT_1 + N^2$$

or

$$Q^2 + 2NQ = WPT$$
$$Q_1^2 + 2NQ_1 = WPT_1$$

Multiplying the first equation by $\frac{Q_1}{Q}$ and changing the sign we have:

$$-Q^2\frac{Q_1}{Q} - 2Q_1N = -WPT\frac{Q_1}{Q}$$
$$Q_1^2 + 2Q_1N = WPT_1$$

Solving these two equations simultaneously it is found that

$$Q_1^2 - Q^2\frac{Q_1}{Q} = WPT_1 - WPT\frac{Q_1}{Q} = WP\left(T_1 - T\frac{Q_1}{Q}\right)$$

or

$$WP = \frac{Q_1^2 - Q^2\dfrac{Q_1}{Q}}{T_1 - T\dfrac{Q_1}{Q}}$$

$\frac{Q_1}{Q}$ is the ratio of the discharges corresponding to the two points A and B, hence it is appropriate to represent $\frac{Q_1}{Q}$ by the symbol R, meaning ratio of the Q's. Inserting this symbol for $\frac{Q_1}{Q}$ in the foregoing equation there results:

$$WP = \frac{Q_1^2 - R_qQ^2}{T_1 - R_qT}$$

This equation is the mathematical tool which will be employed to verify the fundamental equation.

USE OF MATHEMATICAL TOOL

If the fundamental equation is true, as assumed, then any pair of points taken on an actual time-discharge curve from a filter should give, when substituted in equation H, the same value of WP regardless of where the pairs of points are selected.

If a number of pairs of points are used on the same actual time-discharge curve and the resulting WP's are approximately the same, the fundamental equation is verified.

APPLICATION OF THE MATHEMATICAL TOOL

In securing a time-discharge curve from a filter the readings are always plotted commencing with the first rushes of liquid. Since in any filter base there is an

*Metallurgical and Chemical Engineering, Vol. 15, No. 4, Aug. 15, 1916, page 198, by author.

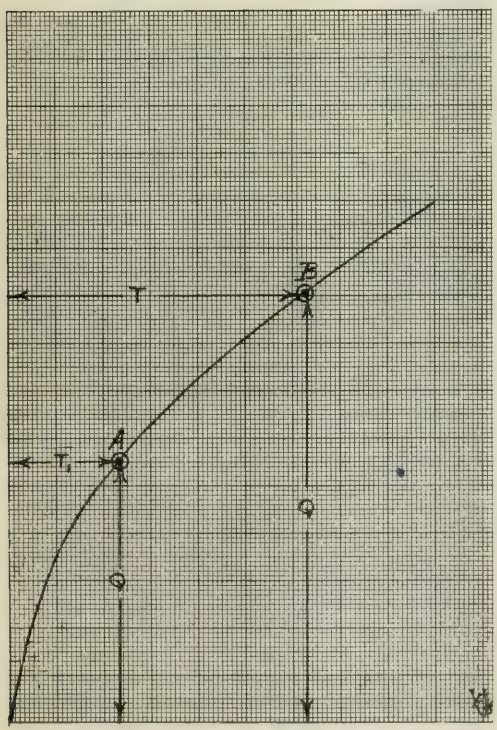


FIG. 7—TIME-DISCHARGE CURVE

initial loss of solids through the openings therein, it follows that the time-discharge curve would vary from that corresponding to the theoretical. The initial loss of solids is called "leakage" and the effect is to augment the total discharge.

Another cause of variation from the theoretical in a time-discharge curve from a filter is lack of constant pressure conditions. In the writer's own apparatus it is quite impossible with a hand-pump to keep the pressure constant during the first few moments of a run.

The mathematical tool, equation *H*, should not therefore be applied to the time-discharge curve from a filter in the form ordinarily obtained. Application to such a curve because of the above errors would be misleading, and the values of *WP* obtained therefrom would not be similar.

AN AXIOM OF FILTRATION

In an effort to overcome these seemingly insurmountable difficulties an axiom of considerable importance in the field of filtration was deduced, namely, that the time-discharge curve from a filter may have its origin at any corresponding points of *Q* and *T* and upon analysis will produce the same values of *WP* as though the origin was at the actual commencement of the run. In order words, in order to analyze a time-discharge curve we do not require the entire curve but only two points on the same.

FIG. 8—CONDITIONS AT COMMENCEMENT AND DURING RUN

To better understand this statement the following explanation is given:

In Fig. 8 is shown at (*a*) the conditions at the commencement of a run. At the moment shown the total resistance to flow is that of the filter base of thickness *A*. In the fundamental equation this resistance corresponds to *RM*.

In Fig. 8, at (*b*) is shown the conditions when the point of origin of the curve is taken at some time later than at the commencement of the run. Here the resistance to flow is that of the filter base plus that of the cake already deposited, or the total resistance through thickness *B*. This resistance also corresponds to *RM* of the fundamental equation.

It should now be evident that the fundamental equation holds whether the run is started at (*a*) or at (*b*), Fig. 8. In the first case the initial resistance is that of the cloth only (if the filter base is cloth) while in the second case the initial resistance is greater, equal to the sum of the resistances of the cloth plus that of the cake deposited up to the initial point. The conditions in the second case are the same as though a cloth of resistance equal to sum of the resistances of the cloth actually used plus cake deposited at the time under consideration were employed. Hence it is a matter of indifference whether a run commences at the start of the process of filtration or at some other point —the analytical results would be identical as far as *WP* is concerned. This fact is a matter of importance not only because the difficulties always attending the commencement of a run can be very easily avoided by its use, but also because one can analyze a discharge curve by taking only two sets of readings of time and discharge, both of which are referred to a common origin.

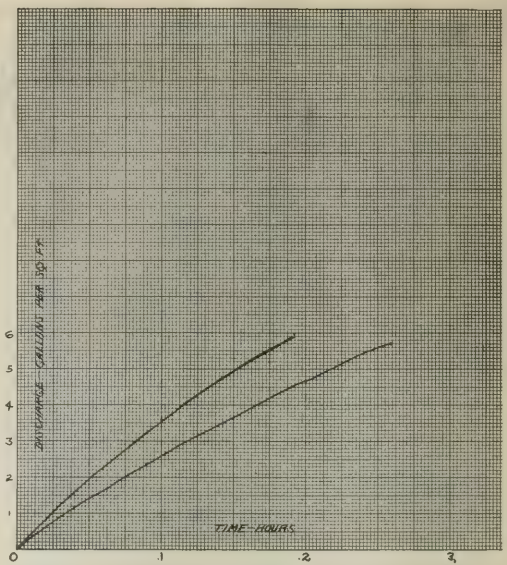


FIG. 9—TIME-DISCHARGE CURVES FROM SAME RUN, BUT HAVING DIFFERENT ORIGINS

In Fig. 9 are shown two curves from the same run, but having different origins. Should these two curves be analyzed for *WP* by means of equation *H* the two values of *WP* should be the same.

MIXTURE EMPLOYED TO PRODUCE THE ACTUAL TIME-DISCHARGE CURVES

In order to produce the actual time-discharge curve a working medium should be employed which will coincide with the assumptions upon which the fundamental equation is based. One assumption made is that the solids contained in the mixture are held in permanent suspension. A medium which has this qualification is of course impossible to find. It might be practical to obtain a liquid containing very minute solids in nearly permanent suspension, but to use it would involve the handling of large quantities of the mixture per unit of filtering area, a condition unsuited to the hand-operated apparatus available. After much consideration it was decided to employ a mixture of Kieselghur prepared in a manner calculated to minimize the effects of sedimentation. A thin mixture of this material and water was made and allowed to stand and settle for a period of one hour. Only the supernatant or unsettled portion was used in the run. It was assumed that since the supernatant portion had demonstrated its ability to stay in suspension for an hour, it would surely do so for a run which was less than one-half an hour in length. A little experimentation was carried out in order to ascertain what ratio of water to Kieselghur was best to use and how great a depth of the supernatnat liquor could be safely drawn off. Three 250 c.c. graduates were filled with different mixtures of Kieselghur and water. One had about a 2 per cent mixture, another

FIG. 10 — SHOWING THE THREE TEST MIXTURES BEFORE SETTLING

FIG. 11 — SHOWING THE THREE TEST MIXTURES AFTER SETTLING ONE HOUR

about 1 per cent and the last about ½ per cent. The contents of each was thoroughly agitated and then allowed to settle for a period of one hour. Figs. 10 and 11 show the appearance before and after settling. It was found that a portion of the solids settled to the bottom. The line of demarcation between this portion of the solids and the opalescent upper portion was quite sharp. There was no selective suspension of solids in the upper portion as far as the naked eye could detect. The distribution of solids appeared to be uniform throughout, producing a liquid of the same opalescence from the line of demarcation to the surface of the liquid. It was decided to use as a working medium for the test a liquor corresponding to the upper portion of the sample containing the smallest amount of solids. Measurements showed that about 14 per cent of the total mixture consisted of the dense portion.

For the test the water and Kieselghur were mixed together in a receptacle shown in cross-section in Fig. 12. After agitation the mixture consisting of 5⅛ oz. of Kieselghur and 8 qt. of water was allowed to settle for one hour. At the expiration of this period the upper portion was drawn from the lower portion by opening the drain valve. The height of the nipple inserted in the drain hole was such as to leave more than 18 per cent of the total mixture in the receptacle. This, according to the results of the test in the graduate given above, assured that none of the heavy mixture passed downward through the nipple and drain. It was found by a preliminary experiment that the nipple allowed 1½ out of 8 qt. to remain undisturbed.

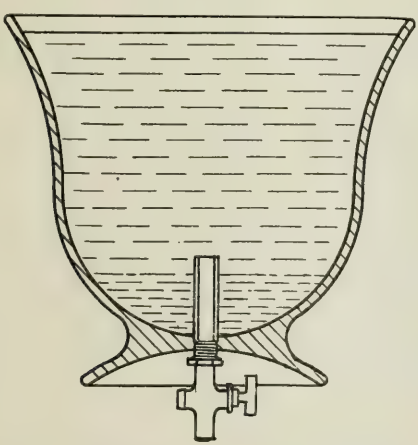


FIG. 12—CROSS-SECTION OF TANK SHOWING METHOD OF DRAWING OFF SUPERNATANT PORTION OF MIXTURE

The upper portion which passed out of the drain was used in the test. A pressure of 30 lb. per square inch was employed.

FILTER PRESS USED AND PLACE OF TEST

The apparatus employed is shown in Fig. 13, and arranged for this test as in Fig. 14. The frame measured 4 in. in height, and the mixture entered the upper head. The filter base consisted of No. 10 duck. Place of test, Basement Laboratory, 178 Union Avenue, Batavia, Ill. Date of test, Nov. 24, 1916.

OBTAINING THE TIME-DISCHARGE CURVE DATA

After agitation, the mixture stood in the receptacle from 2 p. m. to 3 p. m., after which the bottom drain was opened and about 6½ qt. of upper liquor drawn off and set aside in glass bottles. The above quantity was all that the height of nipple would allow to flow away. Next, the nipple was removed and the heavy liquor allowed to pass out. The receptacle was then rinsed, the drain closed and the upper liquor emptied therein from the bottles.

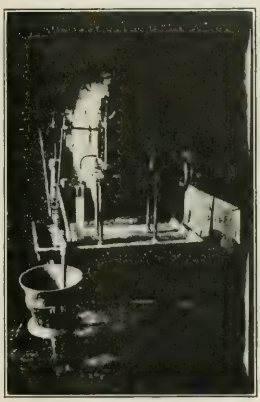


FIG. 13—FILTER PRESS AS USED IN THE FIRST TEST. THE STRAIGHT HORIZONTAL INLET PIPE AND THE CURVED OUTLET PIPE CAN BE PLAINLY SEEN

By opening and closing appropriate valves, the liquor was caused to circulate freely through pump and piping to make sure that nothing but the prepared mixture would reach the filter.

Before closing the filter and immediately preceding the run the frame was filled with liquor. This eliminated air pockets and caused each run to start at almost the instant pressure was applied. After closing the filter the valve to same was shut and the pressure to be used in the test built up in the pump and piping.

In starting the run the valve to the filter was opened and the pump started simultaneously, the pressure being maintained as constant as possible. A bottle was previously put in position to catch the issuing filtrate. At the expiration of the first time-interval the first bottle was quickly removed and another substituted with no appreciable loss of filtrate.

Pressure was kept constant by placing weights on the handle of the pump. This acted as a pressure regulator, making it only necessary to raise the handle

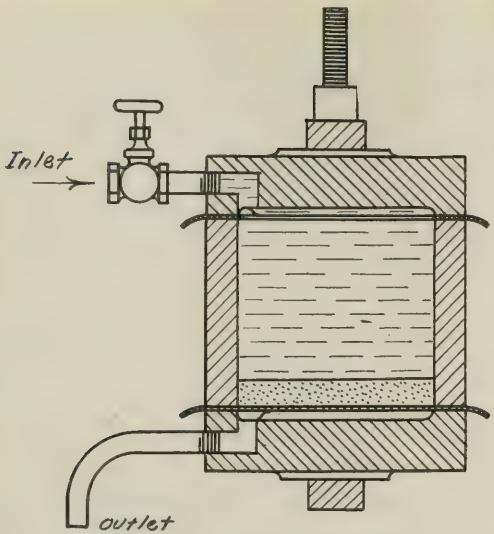


FIG. 14—CROSS-SECTION OF FILTER AS USED IN FIRST TEST

when it had descended by its own weight to a certain low position.

The pump used was a single-acting, outside-packed, 1½-in. x 3-in. plunger pump hand operated.

Simultaneous time and discharge readings were as follows:

Reading	Time	Interval Discharge in c. c.	Time Increment in Minutes
1	3 20	0	0
2	3 20¾	524	¾
3	3 22	339	1¼
4	3 23½	294	1½
5	3 25	233	1½
6	3 27	256	2
7	3 29½	272	2½
8	3 32	238	2½
9	3 35	250	3
10	3 38	236	3
11	3 41½	249	3½
12	3 45	233	3½

In order to arrange these data in a manner to avoid as much confusion as possible when equation (*H*) is applied, the first two columns in the following tabulation were computed from the data above.

Reading	Time Intervals in Hours	Interval Discharge in Gallons per Sq. Ft.	Total Time in Hours	Total Discharge in Gallons per Sq. Ft.
1	0	0	0	0
2	.0125	2.772	.0125	2.772
3	.0208	1.793	.0333	4.565
4	.0250	1.555	.0583	6.120
5	.0250	1.232	.0833	7.352
6	.0333	1.354	.1166	8.706
7	.0416	1.439	.1582	10.145
8	.0416	1.259	.2	11.404
9	.05	1.322	.25	12.726
10	.05	1.248	.3	13.974
11	.0583	1.317	.3583	15.291
12	.0583	1.232	.4166	16.523

Fig. 15-A is the graph of these data. This, then, is the time-discharge curve as experimentally determined.

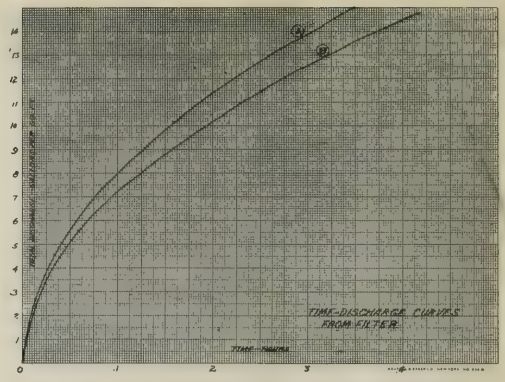


FIG. 15—TIME-DISCHARGE CURVES FROM FILTER

It now remains to apply equation (H) and see whether or not these practical results agree with the theoretical deductions.

APPLYING THE MATHEMATICAL TOOL.

Let us select the various origins at the points indicated by the zeros in the table below. The first origin is taken at run No. 4. This is done as previously explained to eliminate causes of error which are almost certain to exist in the first readings due to initial leakage and inconstant pressure conditions.

Reading No.	Origin No. 1		2		3		4		5		6	
1												
2												
3												
4	0	0										
5			0	0								
6					0	0						
7							0	0				
8									0	0		
9	.1916	6.608	1 666	5 375							0	0
10					.1833	5 269	.1416	3 83	10	2 571		
11											1083	.2566
12	.3583	10.4	333	9 174	.3	7 82	2583	6 38	2166	5 121	166	3 798

The top oblique line of zeros are the origins, both of time and discharge. Six pairs of origins have been taken in order that there may be six computed *WP*'s to compare.

In case the fundamental equation is correct, and the working medium fulfills the assumptions made, then all of the six *WP*'s should be the same.

The middle line of figures in the above table are the *T*'s and *Q*'s for each of the six origins, the *T*'s being the left hand figure of each pair. Similarly the bottom row of figures are the *T*'s and *Q*'s for each of the origins, the *T*'s being the left-hand figure of each pair.

The equation into which each of these six different sets of *T*'s, *Q*'s, T_1's and Q_1's are to be substituted in order to solve for the *WP* corresponding to each origin is equation (*H*) or:

$$WP = \frac{Q_1^2 - R_0 Q^2}{T_1 - R_0 T}$$

In the tabulation below the *T*'s, *Q*'s, T_1's and Q_1's are listed, the other factors deduced, and the *WP*'s obtained:

Factor	Origin No.					
	1	2	3	4	5	6
T	.1916	.1666	.1333	.1416	.1	.1083
T_1	.3583	.333	.3	.2583	.2166	.1666
Q	6.608	5.375	5.269	3.83	2.571	2.566
Q_1	10.40	9.174	7.82	6.38	5.121	3.798
Q^2	43.67	28.89	27.77	14.67	6.612	6.585
Q_1^2	108.30	84.1732	61.1539	40.7164	26.2316	14.4319
RqQ	1.574	1.706	1.483	1.665	1.991	1.48
RqQ^2	68.77	49.3161	41.2165	24.4464	13.170	9.74857
RqT	.301848	.284428	.27225	.23598	.19917	.1603
Q_1^2—RqQ^2	39.531	34.857	20.943	16.273	13.061	4.6824
T_1—RqT	.056476	.04891	.02745	.02235	.01756	.006289
WP	699.9	712.6	763.0	728.0	743.7	761.8

DISCUSSION OF THE RESULTS

A study of the results obtained shows that the value of *WP* for the origins is nearly but not quite constant. The greatest variation is very small. Plotting these values as shown in Fig. 16 at *A*, one is at once struck with the fact that such variation as occurs is a consistent one, the *WP*'s increasing in value the farther the origin is removed from the commencement of the run. This suggests that the variation is due to the changing of one or more of the constants represented by *WP*. Let us consider each of these factors as a possible cause of departure from the theoretical. As given previously:

$$WP = \frac{2KP}{R\%_c}$$

It is evident that either $2KP$ constantly increased or $R\%$ constantly decreased. *P*, the writer knows, did not increase as the pressure regulating device would not permit it. An examination of the dried cake shows in the fracture no strata or other evidences of a varying resistance. The trouble therefore probably lies in "*K*," the rate of deposition, or in "%" the per cent of solids held in suspension.

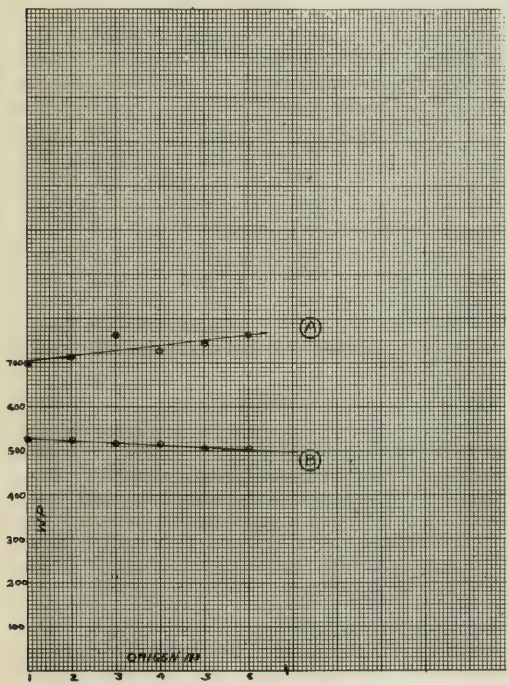


FIG. 16—RELATION BETWEEN *WP* AND DISTANCE FROM COMMENCEMENT OF RUN

SEDIMENTATION PROBABLE CAUSE OF DEVIATION

Sedimentation within the filter press during the run might well account for the apparent variation of these two factors. If such is the case the *WP*'s must be a very delicate measure indeed of sedimentation for it must be remembered that the mixture used was the supernatant portion of a mixture which had settled for one hour, while the run under analysis was only 25 minutes in length. The rate of settling in the mixture employed is undoubtedly approximately constant over a period of 25 minutes, while on the other hand the rate at which the cake is deposited by the process of filtration is not constant but decreases as the filtrate is discharged. In the case of origin No. 1 there was a certain thickness of cake already deposited at the start, at origin No. 2 a somewhat thicker cake had been deposited, similarly each succeeding origin has a thicker cake deposited at the start than the one preceding. Therefore the average rate of settling due to the process of filtration alone uniformly decreases as the origins are taken farther away from the commencement of the run, thus the total settling effect in each case is equal to the sum of the effect due to filtration, a decreasing quantity; and that of sedimentation, a constant quantity. The combined result being a decreasing sedimentation effect as the origin is taken away from the commencement of the run. This is in accordance with the results obtained and may therefore account for the variation. The effect is the same as though the rate of deposition *K* were increased or the per cent of solids %, decreased.

MEANS OF PROOF AS TO WHETHER SEDIMENTATION IS CAUSE OF VARIATION

Obviously if the *WP*'s increase as they are taken away from the origin when the settling effect due to

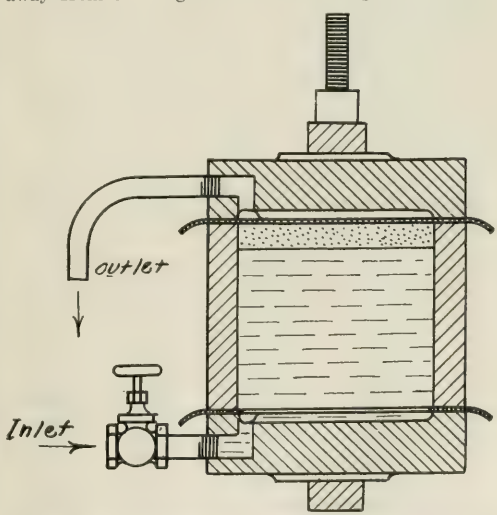


FIG. 17—CROSS-SECTION OF FILTER AS USED IN SECOND TEST

sedimentation acts in the same direction as that due to filtration it is to be expected that the *WP's* would do the opposite or decrease in value, as they are removed from the origin, in case the effect of filtration be caused to operate against that of sedimentation. If such is found to be the case it would serve to confirm the deductions already made, and tend to show that the fundamental equation is correct.

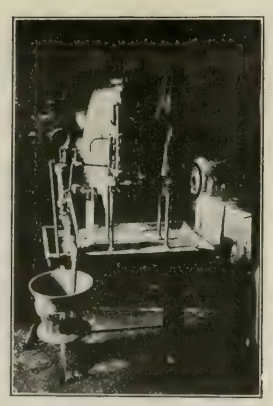


FIG. 18—FILTER PRESS AS USED IN THE SECOND TEST. THE RELATIVE POSITIONS OF THE INLET AND OUTLET PIPES AS COMPARED WITH FIG. 13 CAN BE EASILY NOTED

CAUSING SEDIMENTATION TO ACT AGAINST FILTRATION

In order to cause the settling effects of sedimentation and filtration to act against one another, the experimental filter press was arranged with the filter-base on the top side of the horizontal frame instead of below as in the first test. Fig. 17 shows a cross-section of the apparatus while Fig. 18 is a photograph of the filter press as used. The mixture employed was prepared precisely as was that used in the first test. The pump, the method of procedure and all else other than the location of the filter-base remained the same. Date of the test was Nov. 26, 1916. Mixture was settled from 3.35 p. m. to 4.35 p. m. Data readings were as follows:

Reading	Time	Interval Discharge in c. c	Time Increment in Minutes
1	4.46	0	0
2	4 46¾	470	¾
3	4.48	310	1¼
4	4 49½	258	1½
5	4.51	205	1½
6	4.53	228	2
7	4 55½	247	2½
8	4.58	215	2½
9	5.01	230	3
10	5.04	208	3
11	5 07½	221	3½
12	5.11	203	3½

Arranging these data as done in the previous test:

Reading	Time Intervals in Hours	Interval Discharge in Gallons per Sq. Ft.	Total Time in Hours	Total Discharge in Gallons per Sq. Ft.
1	0	0	0	0
2	0125	2 486	0125	2 486
3	0208	1.678	0333	4 154
4	0250	1 365	0583	5 519
5	0250	1 084	0833	6 603
6	0333	1 206	1166	7 809
7	0416	1 306	1582	9 115
8	0416	1.137	2	10 252
9	05	1.216	25	11 468
10	05	1 10	3	12 568
11	0583	1 169	3583	13.737
12	0583	1.074	4166	14 811

In Fig. 15 at *B* is shown the graph of these data. The fact that this curve is somewhat lower than that of the first test is doubtless due to a slight difference in the mixtures, the method of preparation permits a certain amount of error.

Arranging and selecting the origins in a manner similar to that done for the first test:

Reading No.	Origin No. 1		2		3		4		5		6	
1												
2												
3												
4	0	0										
5			0	0								
6					0	0						
7							0	0				
8									0	0		
9	.1916	5.951	.1666	4 867							0	0
10					.1833	4 761	.1416	3 455	.10	2 317		
11											1083	2.269
12	3583	9.296	.333	8 211	.3	7 005	.2583	5 698	2166	4 571	166	3.343

Solving for each of the *WP*'s as done in the previous test, the following tabulation results:

Factor	Origin No. 1	2	3	4	5	6
T	.1916	.1666	.1833	.1416	.1	.1083
T_1	.3583	.333	.3	.2583	.2166	.166
$Q_.$	5.952	4.867	4.761	3.455	2.317	2.269
Q_1	9.296	8.211	7.005	5.698	4.561	3.343
Q^2	35.43	23.69	22.67	11.93	5.37	5.152
Q_1^2	86.42	67.43	49.07	32.47	20.80	11.18
R_Q	1.561	1.686	1.471	1.649	1.968	1.473
$R_Q Q^2$	55.33	39.97	33.35	19.68	10.81	7.59
$R_Q T$	.2993	.2810	.2697	.2336	.1968	.1595
$Q_1^2 - R_Q Q^2$	31.09	27.46	15.72	12.79	9.99	3.59
$T_1 - R_Q T$	.0590	.0523	.0303	.0247	.0198	.00707
WP	526.95	525.04	518.81	517.83	504.54	505.51

DISCUSSION OF RESULTS WITH INVERTED FILTER

Observing and plotting the *WP*'s, as shown in Fig. 16 at *B*, it can be noted that the values are nearly alike, the variation such as it is being a consistent one and precisely the opposite from that observed in the first test, viz.: decreasing as the origins are removed from the beginning of the run. This serves to indicate that the small variation from the theoretical *WP* is caused by a very minute sedimentation within the filter press itself and substantiates the fundamental equation for filtration as deduced in a preceding article.

In subsequent articles still more theoretical discussions are necessary before the solution of actual problems can be attempted. The foundation of a new science must first be built firmly in order that the superstructure of practical application will be upon a substantial basis.

Batavia, Ill.

The Wet Thiogen Process.—The Thiogen process for eliminating sulphur dioxide from smelter fumes and converting it into elemental sulphur, invented by Professor S. W. Young of Leland Stanford University and controlled by the Thiogen Company, has been described in this journal March 15, 1917, page 309. The Bureau of Mines has recently finished an investigation of the "wet" process and published the results in Bulletin 133, by A. E. Wells. The conclusions from this work were that in some localities the process can be carried out successfully for the recovery of sulphur and sulphur dioxide in waste smelter gases on a commercial scale and at a cost of about $12 to $13 per ton of sulphur produced.

Independent Laboratories in the Engineering Industries

By Clayton H. Sharp

The importance of laboratory work in connection with our national industries is more and more recognized, and there is no little discussion of suitable ways and means for promoting it. With the sharpened competition which must ensue at the close of the war which is now paralyzing the peaceful industries of the world, any and all means for increasing our industrial efficiency will be considered with a care which the easy-going times of the past has not accorded to them.

Our great manufacturing organizations are for the most part quite awake to the fact that laboratory testing and research are necessary and indispensable adjuncts to the growth and development of their industries. They realize that it is to the laboratory that they must look for radical or fundamental advances in the materials, methods and processes of production. They have established splendid laboratories and have attracted to them some of the greatest scientific men of the country. The product of these laboratories has been of enormous value—a value which cannot be measured in money, for it includes engineering and scientific discoveries which become the permanent possession of the human race and add to the prosperity and happiness of all future generations.

The manufacturers of smaller resources have not, however, made a correspondingly large use of laboratory assistance. This may be ascribed to two causes: first, that they have not been so fully aware of their own need for laboratory assistance and of the possibilities of laboratory work in increasing their efficiency, bettering their product, and broadening their scope; and second, because of practical difficulties in securing laboratory facilities which correspond to their needs. This paper is intended primarily to deal with the latter phase of the situation.

Laboratory or research work is commonly divided into two classes, both of which are important in connection with our national industries. First, there is the work in "pure science"—primarily the work of the university. Second, there is the work in "applied science," or in industrial research. Dr. J. J. Carty[1], in his address as president of the American Institute of Electrical Engineers, has very clearly and aptly drawn the distinction between research in pure science and research in applied science when he said that it lies neither in the subject matter, which may be identical, nor in the methods, which may the same, but in the motive. To quote his words:

> "Industrial research is always conducted with the purpose of accomplishing some utilitarian end. Pure scientific research is conducted with a philosophic purpose, for the discovery of truth, and for the advancement of the boundaries of human knowledge.
>
> The investigator in pure science may be likened to the explorer who discovers new continents or islands or hitherto unknown territory. He is continually seeking to extend the boundaries of knowledge.
>
> The investigator in industrial research may be compared to the pioneers who survey the newly discovered territory in the endeavor to locate its mineral resources, determine the extent of its forests, and the location of its arable land, and who in other ways precede the settlers and prepare for their occupation of the new country."

Evidently the industrialist who, to carry the analogy further, may be likened to the settler in the new territory, is dependent upon both classes of investigators; on the investigator in pure science because it is he who indicates the existence of a field heretofore unknown; on the industrial investigator because it is he who discovers the commercial possibilities which the field contains.

Further, the organization which is pre-eminently fitted to carry on the primary work of pure scientific investigation is the university. We must look to the university to discover and to foster the men having those rare and peculiar gifts of imagination, of transcendent patience, of unselfish devotion, which go to make up the explorer into the unknown regions of physical and chemical science. It is the university which must furnish these men the surroundings and the facilities which are required for the prosecution of their work.

For the adequate pursuit of industrial research, however, it is necessary to look to organizations constituted differently from the university. Industrial research having as its end the accomplishment of a definite result of commercial value accruing primarily only to the promoter of the work, it is evident that an institution organized like the university primarily for an educational purpose, and supported largely by endowments or by public funds, cannot justly devote any considerable portion of its energy or resources to any purpose which is not for the benefit of the public at large. The technical schools in this respect are in the same class with the universities with the important exception that a technical school is in general better situated for the conduct of industrial research work than is the university from the fact that its activities are along industrial lines. Hence we find that many of the great industrial corporations in this country have, as has been said, met their own needs by establishing their own private industrial laboratories. For the industries at large, however, this affords no adequate solution of the laboratory problem, for it does not apply to the multitude of concerns, individually smaller than the great corporations, but in the aggregate of enormous industrial importance. The importance of laboratory work to the smaller concerns is relatively just as great as to the larger ones (yet each by itself is unable to support economically and efficiently an adequate laboratory), and the problem is to find the best means of supplying their needs in this particular.

One possible solution is for the smaller manufacturer to take his laboratory problems to a technical school for solution. This plan, while it may work out admirably in many cases, is open to the objection which has been mentioned above, namely, that the funds of the institution, being given for a public purpose, should not be diverted to private ends. However, it may be urged that it is to the advantage of the technical school to accept a certain amount of industrial work, not only in research but also in testing. Such work necessarily brings both instructors and students into contact with certain practical problems of the outside industrial world, too often a world of

[1]Carty. Proceedings A. I. E. E., Vol. XXXV. page 1411. October, 1916.

which they know much in theory but little in practice. The effect of this contact cannot but be broadening and helpful to the technical school and to its students, and if this advantage is sufficiently substantial, the theoretical disadvantage of diverting the attention and the resources of the institution to a limited extent to matters which are particularly the affair of private individuals or corporations is more than counterbalanced. Added to this advantage to the technical school are certain others, among which may be mentioned that incidentally the inadequate salaries of the faculty may be augmented to some extent and the instructors thereby put into a position more nearly in accord with the demands which are made upon them. To the industrial concern a recourse to the laboratory of a technical school may offer the advantage of furnishing a service for a smaller expenditure than would be necessary if all of the overhead and incidental charges were included, which under similar circumstances a commercial organization would have to make.

As against the advantages so outlined there are certain disadvantages which must be given careful consideration and due weight. We have noted that taking on a piece of industrial work has the effect of bringing instructors and students into contact with practical industrial problems and thereby broadens their vision and increases their usefulness. To the industrialist who presents the problem, however, the very lack of knowledge of practical details very greatly lessens the value of the technical school as an organization for the accomplishment of his purpose. Every technical problem is surrounded by limitations and special conditions which may not appear to be of controlling importance (from an academic standpoint) but which if not given their practical weight annul the solution. Considerations of cost, of the intellectual and psychological limitations of workmen, of transportation, or market conditions, of company policy, of technical and commercial usage in the field—any or all of them may have their influence on the result. The technical-school men, if less in touch with practice, are evidently at a disadvantage in the solution of problems involving these elements. The technical school, being organized and equipped for purposes of education and not for purposes of testing or industrial research, is frequently at a disadvantage on account of the limitations of its laboratory equipment, or the amount of power available, and on account of the lack of a business or technical organization especially designed to prosecute industrial problems which it never was designed to handle, with promptitude, accuracy and engineering commonsense. It must be remembered that while many discoveries are made by laboratory experiments on a small scale, many of these are not applicable to industrial exploitation for the reason that elements which in small-scale experimentation are of negligible importance, often become controlling factors when the scale is changed to correspond to practical production. A chemist in his laboratory may effectually close a flask with a cork; a similar procedure does not apply at all to a spouting oil well. He may evaporate to dryness a dilute solution for the purpose of recovering a small residue and never once think of the gas which he uses in the process. If he were dealing, however, with the same operation on a scale ten thousand times as big, the matter of fuel and of containing vessel might offer insuperable obstacles to commercial success. Small-scale experimentation teaches but little regarding the proper design of a switch to open a high-tension power circuit. Hence apparatus which is quite adequate for the small-scale work of the college laboratory may be entirely inadequate when experiments are required looking toward the industrial application of a process.

In speaking of this feature of industrial work in educational institutions, Dr. Steinmetz[2] in a recent address said:

> "Unfortunately this limitation for research work in accordance with the available facilities is not always realized, and especially educational institutions not infrequently attempt research work, for which industrial laboratories are far better fitted, while research work for which the educational institution is well fitted, which the industry needs, but cannot economically undertake, is left undone."

Prof. James Swinburne[3], in a lecture on "Science and Industry," delivered at Kings College recently, has pointed out that the instructor in technology tends as time goes on to be less and less in touch with practical conditions and more and more of an academic scientist. In general this is because only those are likely to take up the teaching profession who have less taste for engaging in the practical work of industry and their own successors are as a general thing the less practical ones of their own students. The academic scientist, on the other hand, is a master of his subject, for his science like himself is academic, and in his own field he is pre-eminent. Thus the tendency of the technologist to become academic is a tendency for him to follow his own proper bent and to employ his energies in the direction in which they will be most effective.

Since to refer the problems of the industry to the technical schools for investigation does not offer a satisfactory solution of the problem, some other way must be sought. This may be found along the lines indicated by Dr. Carty when he said:

> "One of these is for the manufacturer to take his problem to one of the industrial research laboratories already established for the purpose of serving those who cannot afford a laboratory of their own. Other manufacturers doing the same, the financial encouragement received would enable the laboratories to extend and improve their facilities so that each of the small manufacturers who patronizes them would in course of time have the benefit of an institution similar to those maintained by our largest industrial concerns.
>
> "Thus in accordance with the law of supply and demand, the small manufacturer may obtain the benefits of industrial research in the highest degree and the burden upon each manufacturer would be only in accordance with the use he made of it, and the entire cost of the laboratories would thus be borne by the industries as a whole, where the charge properly belongs."

Thus is assigned to the independent laboratory an important place in the engineering industries in providing for the smaller manufacturer laboratory facilities comparable with those enjoyed by some of the great corporations. To fulfill properly these functions the independent laboratory must be adequately supported, properly manned and abundantly equipped. Its staff must be organized on broad lines. Its engi-

[2] Journal of the Franklin Institute, Vol. 182, page 711, December, 1916.
[3] The Electrician, London, Vol. LXXVIII, page 182, November, 1916.

neers must be familiar with the practical and commercial features, as well as the technical details of the work which they encounter. It must include physicists and chemists accustomed to look at the fundamental features of the problems presented and to bring to bear upon their solution the methods and the point of view which are inculcated in the university laboratories of research, for the application of fundamental scientific principles to the solution of the problems of industry underlies all true industrial research. The fees charged by such a laboratory must be adequate to cover not only all expenses, but to yield a sufficient profit as well, for "unless industrial research abundantly supports itself, it will have failed of its purpose."

In return for the fees so paid the industrial research laboratory must deal with its clients in a highly confidential manner, conserving for them individually all the results of the work for which they are paying. It must be prepared to turn over to its clients the inventions and patents which are the direct outcome of any specific piece of work. It must organize its work efficiently, so that its costs are as low as is consistent with good work and so that the results are obtained without undue delay. As to equipment; this undoubtedly must be large. The variety of problems which will be brought to it will be of such scope that a great variety of instruments for measuring and for manipulation must be at hand. A very large supply of electrical power is an absolute requisite. These very conditions interpose serious obstacles to the establishment of laboratories of this character. Unless it is organized through the cooperative efforts of a considerable number of industrial corporations operating in the same or in similar fields, a difficulty is sure to be encountered in insuring beforehand its proper support. To some extent a laboratory of this sort must from its very inception possess an equipment representing a very considerable investment. Unless, therefore, the financial support is insured beforehand, no little faith is required on the part of those investing their money in it. When, however, it has been possible to establish a laboratory of this character, the scope of its work may be very large. It may, and should, include not only industrial research proper but ordinary and routine testing, such as is required by manufacturing concerns, by consulting engineers, and others. It should be prepared to make acceptance tests of manufactured articles on behalf of purchasers and a considerable part of its activities may lie in this direction. It should offer facilities to engineers, inventors, and experimenters to carry on laboratory work of their own under its roof and should make available to them all its own facilities.

In carrying out work of this great scope in an adequate and proper manner the independent laboratory will find itself side by side with the technical school as one of the potent features of industrial progress. The staff of such a laboratory would become increasingly efficient through the practical solution of problems of many kinds. The apparatus and other equipment would necessarily take on a diversified character such that new and unusual problems presented could be undertaken without the purchase or construction of special apparatus. As compared with under-equipped and insufficiently-manned laboratories which individual manufacturers might establish for their own use with a most laudable spirit, independent laboratories, supported by formal or informal co-operation, would be far more efficient both as regards the cost of maintenance, the character and extent of the equipment, and the practical results to the industries. In the last analysis the availability and utility of such laboratories depend on the amount of material support which the industrial world is willing to accord to them.

New York City.

By-Products in Electrolytic Copper Refining

By Lawrence Addicks

In a previous article on "Impurities in Electrolytic Copper Refining" (METALLURGICAL & CHEMICAL ENGINEERING, June 15, 1917) the various elements commonly associated with copper were discussed as impurities and their treatment carried far enough to get them out of the refined copper. We therefore left them as anode slimes and purifying plant salts or as furnace slags and flue dust. We have now to discuss the working of these impure metallurgical products into marketable materials.

MARKET

We may broadly divide the possible by-products into three main classes as to their probable disposition as: First, those which are readily marketable in any quantity which such sources are ever likely to supply; second, those which have a limited and therefore sensitive and widely fluctuating market, and, third, those which have at the present time practically no market at all. These groups consist of the following: first, gold, silver, platinum, palladium, lead, nickel and antimony; second, bismuth, arsenic, cobalt, selenium; and, third, tellurium.

Palladium is the only uncommon member of class one. The production of this element is as yet quite small and this amount is readily absorbed by the jewelry and scientific-instrument trade. Practically it has the useful qualities of platinum, but is of about half the density.

Bismuth goes chiefly into the drug trade. Any large production of it floods the market and depresses the price. It is seldom associated with copper in any quantity, although it is the mainstay of electrolytic lead refining.

There is a large market for *arsenic*, which is used chiefly for its poisonous properties in insecticides, etc., but in recent years the great output of arsenious oxide recovered from smelter flue dusts has glutted this.

Cobalt is an element that has not yet found itself. The Canadian Government has conducted a wide investigation as to its possible uses, but aside from the use of cobalt oxide in the manufacture of smalt and for whitening yellow pottery and the use of the metal to give certain minor properties to cobalt-plated ware and cobalt alloys, no marked characteristic giving it a superior value to nickel has been discovered, and so far it has not been found possible to produce it at the price of nickel. Except in one or two notable cases, as in Katanga bullion, cobalt is not associated with copper to any extent.

Selenium was a rare element a few years ago; to-day

a single copper refinery could easily produce ten tons a month, could it be marketed. Its peculiar photo-electric property has not created any tonnage demand, and its only major use is for coloring ruby glass. This creates a steady but very moderate market.

Tellurium could also be produced by the ton, but there appears to be no reasonably extensive market for it. It would seem that the various plants producing selenium and tellurium could advantageously join in trying to develop wider markets for these elements by scientific research.

MARKET REQUIREMENTS

Gold is nearly always sold to the United States Assay Office. There are no requirements as to fineness, but the bullion is weighed, sampled and assayed by the Government. It is then purchased with a "gold check" on the Treasury Department for full value less certain refining charges. These charges are so adjusted that they are greater than those of an outside refiner, unless the gold is nearly pure; but the last traces of impurities are taken out by the government for less than it would cost others who are properly equipped. This is due to the fact that the government is not concerned with interest charges while the gold is in process, while the individual is very much concerned therewith. The result is that it is customary for the refiner to bring his gold up to perhaps 985 parts fine, the balance being chiefly silver (which is not paid for above 992) and sometimes small quantities of the platinum group of metals which are likewise forfeited.

Silver is largely exported to London in normal times because the English market is higher than the American by an amount usually sufficient to pay transfer charges. Under the present war conditions the freight and insurance on trans-Atlantic shipments has become so high that the profit in this movement has been wiped out, and America is beginning to make direct shipments westward to the market in the Orient.

The silver used locally goes to brokers, but little of the home consumption passing directly into the hands of the user.

The chief impurity in bar-silver is copper. For the American market it is customary to produce 999 fine, and for the English 998. As value over 998 is neglected in payments from abroad while penalties are exacted if it runs under that point, care must be taken to bring high grade electrolytic silver *down* in fineness. This is done when melting by the addition of copper wire in sufficient quantity to allow a safe margin above 998 for assay variations. Also, as only even quarter ounces are paid for it is customary to plug the bars with silver to a safe weight above an even quarter. The same result could be obtained by trimming but this would obscure any evidence of theft by trimming in transit.

Tellurium is the main metallurgical enemy of silver and must be thoroughly eliminated from it in order to prevent brittleness in subsequent rolling of the metal.

Printed schedules of the charges of the U. S. Mints and Assay Offices are periodically issued by the Treasury Department and may be obtained upon application. The points of chief interest to a copper refiner in the present schedule are: first, all deposits are subject to a melting charge of $1 per 1000 oz.; second, ordinary doré is charged 1 cent an ounce for parting and refining; third, gold bullion between 950 and 991.75 parts fine is charged 2 cents an ounce for refining while silver contents in such bullion above 992 fine are not paid for; fourth, metals of the platinum group are not paid for, although their presence in quantity will be reported for the information of the depositor, and fifth, government weights and assays control, the weights being to one hundredth of an ounce and the fineness to the nearest quarter-part.

The *platinum group* of metals are sold as a rule in crude shape as a sponge or powder, running 950 fine or better. In passing, it may be of interest to state that the ordinary assay methods for the platinum group give very inaccurate results and that a true assay for platinum and palladium is a tedious and costly operation, involving repeated precipitations in order to free the platinum metals from the last trace of lead sulphate and silver chloride.

Lead is seldom present in any quantity unless it is added in the cupeling operation in the silver refinery. Its market requirements are too well known to need discussion here.

Nickel is used first, as nickel sulfate or as a double ammonium sulfate in nickel plating; second, as anodes; and third, as shot or oxide for steel alloying. The crude sulphate of nickel, iron and copper produced by a purifying plant can be made into a reasonably pure sulphate by wet methods. This is then broken down by heat into oxide which is in turn reduced by carbon to metallic nickel in an electric crucible. Carbon-free nickel can be made electrolytically from this product if desired. Nickel anodes are generally alloyed with more or less iron, although conditions in the trade are improving in this respect with a corresponding improvement in the character of nickel plating. The production of pure nickel salts is very troublesome and should not be attempted unless unusually pure electrolyte is available as a starting point. One of the large manufacturers of this product had so much trouble in meeting the strict requirements of the trade that wet methods of production were abandoned and the salt produced by dissolving pure nickel.

Electrolytic nickel should run 99.80 nickel plus cobalt and should be free from carbon and oxides. The cobalt should not exceed 0.3 per cent and the sulphur should be very low. Small quantities of iron and copper are permissible and a little arsenic is generally present.

Table I gives some examples of the crude by-product salt as made by the refinery which is the raw material for by-product nickel; also analyses of commercial single and double salts as found in the market.

Table I Analyses of Nickel Salts

Source	Type	% Ni	% Cu	% Zn	% Fe	% Co	% As	% Sb	% Pb
A	Crude	25.32	0 82	0.19	3.10	. . . .	1.27	0.29	0 05
B	Single	22.34	None	None	0.002	0.016	None	None	.
B	Double	14.93	0.008	None	Trace	None	None	None	. .
C	Single	20.80	Trace	0.001	0 007	0 053	None	None	None
C	Double	14 80	None	None	0 003	0.067	None	None	None

An example of nickel made in the electric furnace from refinery by-product salt showed 98.98 per cent nickel, 0.29 per cent copper and 0.73 per cent iron.

Antimony is marketed chiefly in "metallic" form as its principal use is in the manufacture of alloys. It should be sufficiently pure to show clearly marked

"stars" on the surface of the pigs. It can also be marketed as a "hard" lead.

Bismuth is produced as metal in very pure form, usually obtained by electrolytic refining.

Arsenic is marketed as a 99 per cent arsenious oxide readily obtained by sublimation from many flue dusts.

Cobalt is marketed almost entirely as oxide. There are three oxides of cobalt and all have a market demand. They are difficult to prepare and the trade requirements are based on previous production rather than on any rational specification. The great use of cobalt oxide is as an offset to yellow cast in clay and similar material, the powerful blue characteristic of cobalt salts being equivalent to a bleach.

Selenium is produced in granular or fused form, 99 per cent pure. The black variety, not too finely ground, is desired by the glass industry.

Tellurium is usually offered in an impure state but no market standards have as yet been developed.

METALLURGY

The general treatment of the electrolyte for the recovery of a crude nickel sulphate has already been discussed in the previous article noted above. This method also gave a cathode sludge of arsenic and copper from which a certain amount of arsenious oxide could be recovered if desirable. The balance of the impurities were either lost in blast furnace slags or concentrated in anode slimes.

The analyses given in Table II are representative of such slimes. The wide variation in the composition is due to different conditions obtaining at different

TABLE II—ANALYSES OF ANODE SLIMES

Per Cent	Raw			Boiled	
	A	B*	C	D	E
Copper	14.3	43.3	20	1.60	1.14
Silver	35.0	17.2	37	41.5	29.5
Gold	0.64	0.12	0.6	0.7	0.7
Platinum	.....	0.00017	...	0.0007	..
Palladium	...	...	...	0.0006	...
Nickel	5.25	0.08	....	0.89	1.07
Cobalt	...	0.006	...	...	...
Arsenic	2.68	3.03	4	1.42	1.20
Antimony	5.35	3.46	8	3.84	5.70
Bismuth	0.46	0.11	... ..	0.37	0.20
Sulphur	1.69	13.21	.	2.48	1.97
Iron	0.17	0.36		0.24	0.26
Lead	2.44	0.76		7.33	18.60
Selenium	5.70	1.20	...	12.94	11.24
Tellurium	2.69	2.10	.	5.72	6.20
Zinc	Trace	0.09	.	Trace	Trace
Silica	4.40	0.18		5.29	4.71

*Burns—Trans. A. I. M. E., Vol. XLVI, page 712.

plants and this lack of a uniform product has been one of the difficulties in the way of a wet treatment of slimes. *A* is an ordinary slime with nothing unusual in the composition. *B* is produced by the electrolysis of converter anodes; its nature is reflected in the high copper and sulphur contents. *D* and *E* are analyses after the slime has been somewhat oxidized and leached with dilute sulphuric acid to remove the excess copper; they show noteworthy amounts of selenium present. The high lead content of *E* results from anodes carrying 0.2 per cent lead.

There is room for division of opinion as to the exact compounds present in anode slimes. The silver, gold, and a large part of the copper in slimes from well-refined anodes are doubtless in metallic or alloy form. Selenium and tellurium may be present in elemental form or as selenides, etc. Lead is probably as sulphate and much of the nickel, iron, cobalt, arsenic, antimony and bismuth in some oxidized form, but antimoniates and analagous compounds as well as simple oxides may easily be present. In general the slime is in an oxidized condition since the prior processes in the converter, the anode furnace and during electrolysis are all strongly oxidizing. The less noble metals are all therefore more or less oxidized in the slime when drawn from the electrolytic tanks.

There is always a high percentage of copper present. In slimes from converter anodes this is due in part to undecomposed matte, but even in slimes from the purest anodes there is a considerable amount of very finely divided metallic copper to be found after all cathode needles, etc., have been carefully screened out. This probably comes from either mechanical disintegration of the anode under electrolysis or from chemical oxidation of cuprous salts formed at the anode. Any one interested in the various possible explanations of this action would do well to consult an article by Dr. Emil Wohlwill on anode disintegration in the 1903 volume of Zeitschrift für Electrochemie.

REQUIREMENTS FOR A SLIMES PROCESS

Perhaps the foremost requirement for a metallurgical process for the treatment of these complex slimes is that there shall be a minimum of loss of the precious metals. We are dealing with material which usually runs 35 or 40 per cent silver and half a per cent of gold (and at times much more). This means that every by-product must be retreated for values contained. The second question relates to the interest on metal value. The slimes are worth about $5 a pound and a process is needed which will turn out the great bulk of the gold and silver promptly. A third desideratum is to be able to recover as by-products any marketable impurities which are present in commercial amounts. Then we have to consider the chemical questions introduced in the parent process of copper refining by the presence of any unusual reagents. Finally we have to reckon with the operating cost of the process in question.

This problem of treating anode slimes is doubtless the most difficult presented by the metallurgy of copper refining, and it is also the one which to-day leaves most room for further improvement. It has always afforded a field of contest for advocates of wet against advocates of fire processes; and the methods used at present employ a mixture of the two, the wet processes, however, steadily encroaching as time passes. We shall first discuss present practise and then the possible points of attack for further improvement.

The general problem as at present handled involves three main steps: first, the production of a nearly copper-free slime; second, smelting this to doré bullion; and third, parting the doré.

SLIMES BOILING

As sulphuric acid is a cheap reagent and as sulphate of copper is the basis of the electrolyte, the obvious method by which to remove the copper from the anode slime is to convert it into sulphate. As copper is not readily soluble in dilute sulphuric acid, however, either strong acid or some oxidizing agent such as air or nitre must be used.

The practice in the earlier plants was to screen the slimes through 60 or 70 mesh copper wire into agitators, using water to force the slimes through the screen. These agitators were lead-lined tanks about six feet in diameter and six feet deep, carrying a two-bladed paddle 2½ in. from the bottom and driven 12 rotations per minute. The blades tended to raise the slimes from the bottom. A charge consisted of perhaps 1000 lb. of slimes. After these were sluiced down into the tank liquor was siphoned off and enough sulphuric acid added to make a 50 per cent solution. A steam pipe heated the charge to the boiling point, the paddles were started and 100 lb. soda nitre added, a few pounds at a time. Owing to the strong evolution of poisonous nitrous fumes the nitre was added only at night and the treatment extended over two and sometimes three nights when the copper was found to be reduced to perhaps 3 per cent. The liquors made were sent to the electrolyte after carefully settling to free them from slimes.

After agitating, washing, and settling the charge, the supernatant liquor was siphoned off and the slimes, now running about 60 per cent moisture, dried to a thick mud carrying 25 per cent moisture by means of closed steam coils. This mud was considered ready for charging into the reverberatory refining furnace.

This method has been subject to many variations in details. At some plants compressed air is used for agitation instead of the paddles. Drying has been accomplished by the use of filter presses, of centrifugals or by direct heat instead of steam. It remained the general method, however, until the development of cyclical purification of the electrolyte which system made objectionable the introduction of large quantities of sodium salts into the electrolyte.

This difficulty was first met by charging raw slimes high in copper directly into the doré furnace. As will be later explained, such a procedure locks up a large quantity of silver in circulating by-products and is very undesirable.

The next step was the development of slimes-roasting and air has now come into general use as an oxidizing agent. In some cases an ordinary roasting hearth is used and in others patented[1] forms of tray hearths, but in any case all that is necessary is to expose a shallow layer of slimes to a low heat with sufficient air passing to hold the temperature below the fritting point (the slimes often ignite and overheat from the heat of oxidation), while being very careful not to stir the bed, and produce dust losses. The resulting calcines are then leached with dilute sulphuric acid which readily reacts with the cupric oxide found in the roasting.

A third process, which is patented,[2] mixes the filter-pressed slimes with concentrated sulphuric acid in sufficient quantity to satisfy the copper present, and heats this mud in a furnace the hearth of which is a steel basin. The slimes and acid are mixed first and pumped into the furnace. The mass is heated to about 450 deg. Fahr. with an oil burner and the mud occasionally stirred. The residues are practically dry and yield their copper sulphate readily when digested in hot water. This operation uses but a chemical equivalent of acid which is an advantage in some cases.

These various oxidizing and leaching processes designed to separate the copper from the rest of the slimes can be made to bring the residues down to 1 per cent or less in copper, with careful handling. The other elements present are also more or less affected by the operation. During the process more or less silver sulphate is formed, but this at once reacts with the copper present to form copper sulphate and metallic silver. In fact boiling is generally continued until the presence of silver in solution is shown by a salt test. When a decided precipitate is shown a small quantity of raw slimes is added to precipitate this silver and it is then certain that sufficient work has been done to oxidize practically all of the copper. In roasting the more volatile elements sublime to a certain extent and such flue dusts are a fruitful source of selenium, for example. Solutions from the boiling tanks always show nickel, arsenic and antimony extraction.

[1]Wales, U. S. Patent.
[2]Keller, U. S. Pat. No. 1,110,493.

SMELTING TO DORÉ

Whatever be the method employed in leaching the bulk of the copper from the slimes, the residue is always smelted to doré in some type of reverberatory furnace. Were the slimes subjected to a quiet fusion three layers of molten material would form with a distinct separation by specific gravity. At the bottom would be a foul doré bullion; in the middle would be what could be called a matte, silver being the principal metallic component and selenium substituting for the usual sulphur; then on top would be an arsenic-antimony slag.

Table III—Analysis of Lead Cupel Slag

	Gold	Silver	Copper	Lead	Iron	Silica
Skimming	0.0017	1.62	5.42	32.51	4.87	14.02

Table IV—Analyses of Doré Furnace Products

Per Cent	Slimes	1st Slag	2nd Slag	Doré	Flue Dust
Copper	2.39	4.25	7.90	2.00	0.1
Silver	40.0	4.03	3.31	96.345	5.0
Gold	0.767	0.041	0.0041	2.37	0.017
Nickel	1.94	7.58	1.02	0.0065	
Arsenic	2.34	1.593	0.73	0.0075	2.65
Antimony	5.91	11.34	3.30	0.0084	10.9
Bismuth	0.343	0.5378	0.64	Trace	
Sulphur	2.80	0.264	0.90		
Iron	0.23	5.63	3.88	0.1233	
Lead	5.43	6.14	2.78		
Selenium	11.89	1.58	11.06	0.0020	35
Tellurium	5.45	1.80	19.36	0.0068	1.5
Zinc	Trace	Trace	Trace	None	
Silica	1.25	19.90	2.26		
Alumina		4.93	2.15		
Magnesia		1.604	1.31		
Lime		1.075	0.18		

It is quite possible to base a process on such a fusion of raw slimes with subsequent separation and special treatment for the three resultant products. However, we should get but about half of the silver and most of the gold in a bullion around 900 fine, while most of the balance of the silver would be tied up in the copper-silver-selenium-tellurium matte. This matte is a troublesome material to handle without making undue losses or tie-up of silver, and it is because the quantity made is more or less proportional to the amount of copper present that it is desirable to eliminate this last element as far as possible before smelting.

The earlier work was done in cupels with the addition of lead, the process being in a cycle of charging, melting, skimming, cupeling with a blast, skimming and pouring. Something like 10 per cent of the lead used in this process would be lost, and the resulting slag

(Table III) would have to be retreated on a lead basis and therefore was generally shipped elsewhere.

Then the use of lead was abandoned in favor of straight reverberatory smelting in small basic furnaces, air being forced under the surface of the bath to promote oxidation. It is interesting to note in passing that the silver furnaces of to-day are as large as the copper reverberatories in the earliest refineries. The general plan of operations is to melt the charge, thin the first slag with such fluxes as silica, soda ash, salt cake, etc., skim, blow the small quantity of matte to a second slag and bullion, skim, fine the doré with air and nitre, skim, and pour. Table IV gives representative analyses of the various metallurgical products produced by such a procedure. While the various columns are not all strictly comparable, they are near enough so to give a good idea of the character of the products. Had not the matte made been charged back or broken down before skimming we should have had another product running about 26 per cent silver and 0.02 per cent gold.

It is interesting to note the relative concentrations of the various elements in the different products—the slimes produce roughly 30 per cent first slag, 15 per cent second slag, 30 per cent doré, and 20 per cent flue dust, plus volatile losses and minus fluxes and furnace material. Perhaps the most striking thing is the "spreading" of the silver-gold ratio, nearly all the gold going directly into the doré while the silver spreads over the various by-products. This ratio as the figures stand is as follows: Slimes, 52.2; first slag, 98.4; second slag, 806; doré, 40.6; flue dust, 29.3.

The gold content of the slags is quite satisfactory metallurgically, but the silver is entirely too high. When the slag is reasonably fusible, it is possible by desilverization—consisting of a melting and collection of the suspended values—to bring the silver down to 0.5 per cent, but as these slags are all retreated in the anode furnace this seldom pays.

The elements which do not readily form fusible slags and therefore float undigested on the surface of the bath and those (such as lead, iron, and antimony) which on the contrary form slags very readily, tend to concentrate in the first slag. It is such an impure and unpromising material that it does not offer much chance for the recovery of by-products. Were the nickel out of the way it could be reduced to an impure antimonial lead.

The second, or soda slag really represents impurities subsequently blown out of the base bullion and matte formed when the slimes were melted. Here we have a decided concentration of tellurium, an element which clings tenaciously to silver. Since sodium salts are generally soluble, over half the total contents of this slag can be leached out with hot water. This is the starting point for the recovery of tellurium.

The small quantity of nitre slag made when fining the doré is charged back into the furnace with the next lot of slimes.

The flue dust shows a remarkable concentration of selenium and it is from this source that the market demand is supplied. Elemental selenium may be readily prepared from this dust in several ways—by fractional sublimation, by leaching followed by electrolytic precipitation, or by leaching followed by chemical reduction. The last-named method is perhaps the most satisfactory. The leaching is generally conducted in the presence of hydrochloric acid and a strong oxidizing agent such as a chlorate and preferably exposed to sunlight. The resulting solution is strengthened in free hydrochloric acid in order to hold back the tellurium, and the selenium is then precipitated as a red powder by sulphur dioxide gas. This powder is melted and skimmed to a bright face, when it is cast into cakes as the black variety. If desired, the powder can be dried in an oven, the heat changing it to the black variety and the baked product then ground for the market. Selenium often runs 99.5 per cent Se and the chief impurities are lead sulphate, arsenic, antimony and tellurium. The lead content is the most difficult to control.

PARTING THE DORÉ

We have two well recognized methods available by which to part gold and silver—the sulphuric acid and the electrolytic. Both are in use and have their advocates but the latter has come into more general use chiefly on account of its greater cleanliness.

In the acid method, the doré is cast into slabs resembling waffles, the indentations giving additional surface for corrosion. The process is very simple, being the production of silver sulphate by the decomposition of strong, boiling, sulphuric acid by silver, sulphur dioxide being given off. The gold is left undissolved and is melted in a crucible, while the silver sulphate, which is readily soluble in excess of free acid, is precipitated upon copper sheets to form sponge silver which is washed and melted. The copper sulphate solution is sent to the copper-refining tanks.

The plant required is inexpensive—needing only a couple of cast-iron pots, a lead-lined tank and a crucible furnace—and the tie-up of values is short, being about 48 hours. On the other hand the process is dirty; hot sulphuric acid is hard to handle; and the fine silver cannot be brought below a third of an ounce in gold. Also, if the doré is high in gold, the acid attacks it slowly and it is necessary to inquart it.

The hot liquor from the kettles runs about 600 grams per litre silver and twice as much free acid. This has to be diluted with water before the silver is precipitated, and the tank house must be able to absorb this free acid. The kettles are fired up and boiled until no solid pieces of doré can be felt with a stirring rod. This takes about eight hours. The liquor is drawn off to a heated settling kettle to free it from entrained gold, fresh acid is added, and then given an additional boil to free the gold of silver. By washing the gold precipitate thoroughly before adding this acid it is possible to make 995 gold sand directly in the kettle. The silver sponge should run 998 or better.

The electrolytic process consists of the electrolysis of doré anodes in a copper-silver nitrate electrolyte. Three methods have been employed—the Thum-Balbach, the Moebius and the Whitehead. The first method uses horizontal carbon cathodes laid as the floor of a shallow earthenware tank, the anodes being carried in a basket within a light cotton bag to collect the gold slimes. At an efficiency of 90 per cent, 3.5 volts per cell is equivalent to a recovery of about 32 oz. silver per kilowatt-hour. The current density is limited to about 35 amperes per square foot by the heating of the electrolyte, as a hot solution means a high loss of free nitric acid.

The silver crystals have to be frequently removed in order to prevent treeing, which will reach and puncture the gold bag.

The electrolyte consists of about 4 per cent copper as nitrate, 2 per cent silver as nitrate, and 0.1 per cent free nitric acid. Copper enters from the doré and silver dissolves in a certain excess, nitric acid being regularly added, but the entrained liquor in the silver sponge removed holds the balance steady. The wash waters from this sponge are not returned to the parting tanks. There is no circulation of the electrolyte and each cell is a complete unit.

The silver crystals are readily washed with water and if the copper in the electrolyte is low, silver very close to 1000 fine can be produced. As this is not desired, however, the copper is allowed to build up to a maximum of perhaps 6 per cent in the electrolyte before any deliberate removals are made.

There is no anode scrap as the remnants of anodes are left in place on the horizontal trays until they are entirely consumed. Cathode silver runs 0.1 oz. per ton in gold or even better.

The gold mud is periodically removed and boiled in strong sulphuric and in nitric acids to remove the silver. This mud is also the raw material for the recovery of platinum and palladium, as mentioned later.

The Moebius process substitutes a vertical system of electrodes which is very much more compact and yields more silver per kilowatt-hour, due to lower tank resistance. The silver crystals drop to the bottom of the tank, in some plants being knocked from the cathode by a simple system of swinging wooden rakes. The anodes are inclosed in sacks. Against the cheaper first cost and somewhat lower power required, there is more care required to prevent gold leaks, the cell is not so open to constant inspection, and there is a small amount of anode scrap made.

The third system, which I have called the Whitehead plan, has not come into general use, although it has been more or less extensively employed at some of the government plants. It uses gelatin to obtain a coherent deposit to be stripped from silver cathodes and duplicates in many ways the conditions found in a copper refining cell.

As compared with the sulphuric acid method of parting, the products are more pure, there is less danger of metal loss, in a large plant the operating costs are somewhat lower, and but little by-product liquor is made. On the other hand the first cost of plant is much greater, in a small operation the operating costs are no lower, while the metal tie-up is at least 50 per cent more.

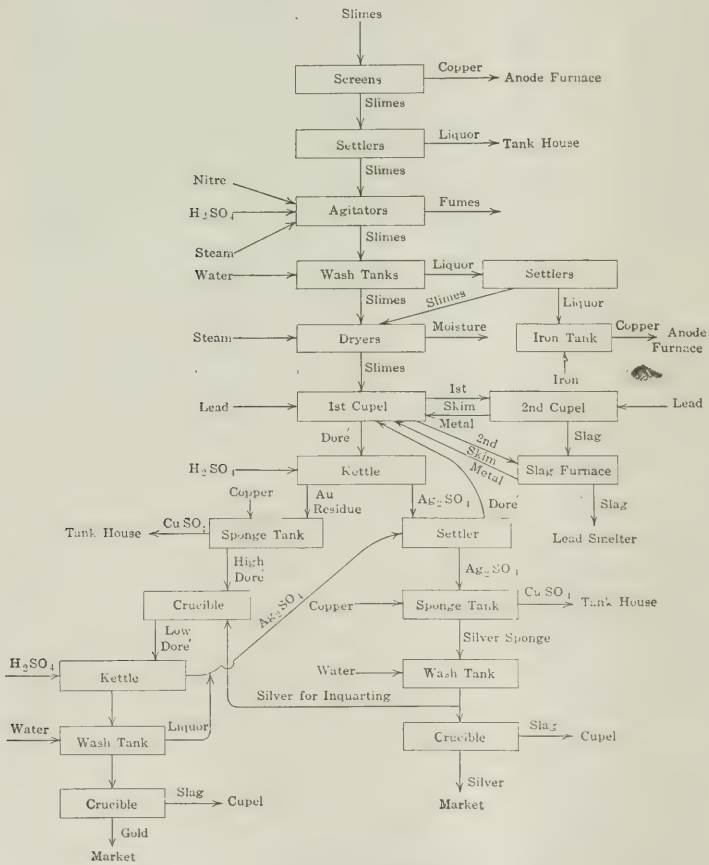


FIG. 1—SLIMES PROCESS 1900

If platinum and palladium are present in the doré we have the choice between electrolytic and chemical recovery. If the gold slimes from the parting are boiled to dissolve their silver in sulphuric acid, these metals remain with the gold which can then be electrolyzed by the Wohlwill process in a chloride electrolyte; if nitric acid is used in the gold boiling, the platinum and palladium go chiefly into solution and after a somewhat tedious treatment may be recovered as double chlorides with ammonium. The platinum is thrown out singly by sal ammoniac from a reduced solution; after oxidation the palladium may be similarly precipitated. Metallic sponges are obtained upon ignition of these precipitates. As these sponges are difficult to melt the metal is usually marketed as a crude powder. The separation between the two metals is quite sharp and a product 98 per cent or better is readily obtained.

The Wohlwill process has two great objections: it ties up a very valuable metal, and it exposes it to possible theft. In ordinary practice the gold does not ap-

pear in solid yellow metal until it is almost ready to ship. Crude, dirty products are hard to sell and do not present the same temptation to laborers handling them. On the other hand the electrolytic process is cleaner, as in the case of silver parting, with the result that most government plants use electrolytic and most private plants chemical extraction. As before stated, the government does not pay for platinum contents of deposits; one reason for this is that the assay method for accurate results is very tedious and expensive and its application would result in great delays in making settlements.

SLIMES PROCESS DEVELOPMENT

The progress already made with the metallurgical problems presented by copper anode slimes may be seen from Figs. 1 and 2 which are flow sheets representing practice twenty years ago and to-day. We may now consider the various points at which the second process may be attacked.

SCREENS

The fact that a certain part of the copper carried in the slimes may be removed by simple screening suggests the possibility of further separation by mechanical means.

The first point of attack here is against the size of the particle—could the slimes be classified in any way by screening? The practice at one plant is to screen out nodules and large pieces by passing the slimes through a 4-mesh screen, and then through a 70-mesh screen, which takes out float slime such as was discussed in Table VI in the last article[3]. Changing the size of this fine screen and then analyzing the slimes gave the results shown in Table V, below, which indicate the hopelessness of such a classification.

A screen analysis of slimes is given in Table VI. Here we happen to have a sample which has some small cathode debris present and the effect of screening this out is at once apparent upon the copper assays and the use of one fine screen is justified. In Table V the assay is for the total slimes passed by the screen while Table VI gives results for a true screen analysis. A 70-mesh screen will ordinarily retain 8 or 9 per cent of the weight of slimes sent it from the 4-mesh, and this quantity may be advantageously returned to the anode furnace.

As the silver and gold are presumably present in metallic form and as they have a higher specific gravity than most of the other elements present, some gravity separation might classify the product. Careful trials with a Wilfley table did not effect sufficient separation, however, to enable any process to be built on such a basis. It is just possible that the application of recent flotation experience might show something of value. It must be remembered that what is necessary is not so much a perfect separation—any process will have to work up its intermediate products for precious metal values—as a scheme whereby the great bulk of the silver and gold will be put on the market promptly, leaving

[3]Impurities in Electrolytic Copper Refining, METALLURGICAL & CHEMICAL ENGINEERING, Vol. XVI, June 15, 1917, p. 681.

TABLE V—ANALYSES OF SLIME THROUGH DIFFERENT SIZE SCREENS

Meshes per Inch	Per Cent Copper	Per Cent Arsenic	Per Cent Antimony
− 4	21.3	6.00	2.44
− 80	19.6	5.39	3.10
−120	19.4	5.50	3.92
−200	21.3	4.30	3.60

TABLE VI—SCREEN ANALYSIS OF SLIMES

Mesh Passed	Mesh Retained	Grams	Per Cent Weight	Per Cent Copper	Grams Copper	Per Cent Total Copper
4	20	319.1	55.6	40.8	130.2	74.3
20	40	101.4	17.6	27.0	27.4	15.6
40	60	54.0	9.4	22.0	11.9	6.8
60	80	30.8	5.4	13.7	4.2	2.4
80	100	14.4	2.5	10.6	1.5	0.9
100		54.3	9.5	Not run		
Total		574.0	100.0	30.6	175.2	100.0

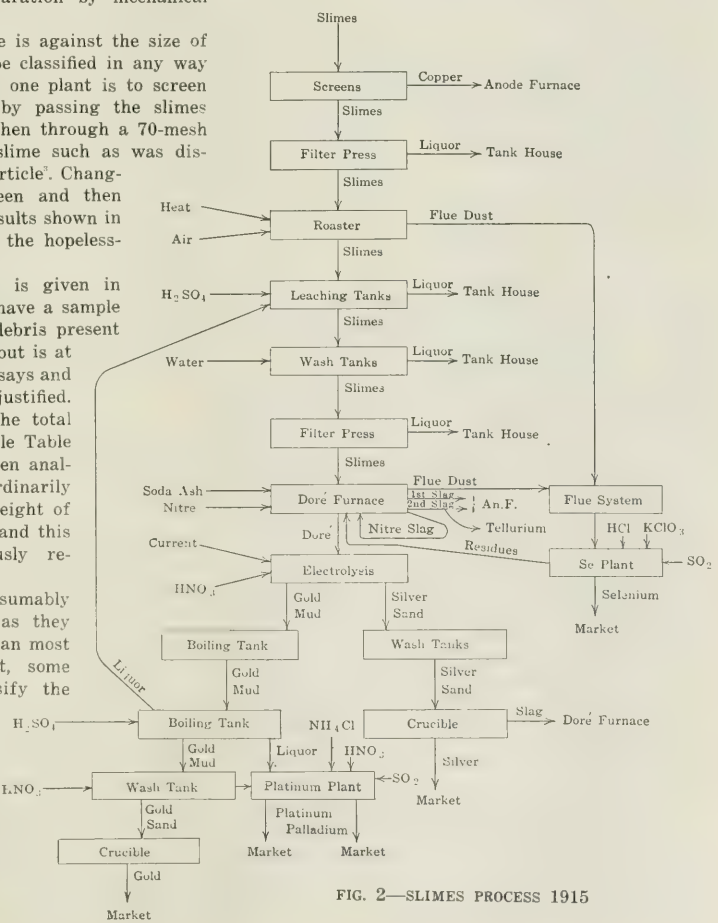


FIG. 2—SLIMES PROCESS 1915

the more tedious working of other by-products until the last. One of the objections to present practice is that the other elements are gradually removed until the pure silver and gold are obtained, thereby holding the entire value until the very end of a long process.

OXIDIZING THE COPPER

The next step in the present process is oxidation of the copper. It has already been pointed out that the presence of any quantity of copper in the doré-furnace charge makes a serious amount of by-product matte high in silver. If the copper is allowed to stand at 15 or 20 per cent and the slimes charged directly into the furnace, instead of obtaining 30 per cent first slag, 15 per cent second slag and 30 per cent doré we should get perhaps 35 per cent slag, 25 per cent matte and only 20 per cent doré, a third of the silver being tied up in the matte. The desirability of the awkward oxidation step has therefore been fully demonstrated.

In the endeavor to simplify this operation, considerable work has been done experimentally with ferric sulphate as an oxygen carrier using the well known reactions:

$$Cu + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4$$

and

$$2FeSO_4 + CuSO_4 + \text{current} = Fe_2(SO_4)_3 + Cu.$$

A diaphragm cell is all that is necessary to carry out this process and chemically it is very pretty. The fact that it has not been successfully applied even in the hands of those skilled in electrolysis bears witness to the great difficulties interposed by a diaphragm cell in an acid process. Later work such as that of Hybinette in nickel or the use of a chemical retarder (Addicks, U. S. patent No. 1,138,921) may reopen this field.

LEACHING

The next step of dissolving the oxidized copper from the slimes is true leaching, and leads to the consideration of the possibility of dissolving the bulk of the slimes at once instead of making this a mere preparatory step to furnacing.

The first suggestive point to be noted is that in any of the oxidation processes it is easy to carry the action to a point where large quantities of silver may be taken into dilute sulphuric acid solution as sulphate. It is further known that by careful temperature regulation, a very high grade selenium product may be obtained in the flue. On the other hand, anything but an incipient roast tends to frit the easily melted slimes, spoiling the physical condition for subsequent leaching and forming undesirable chemical compounds of copper, arsenic, etc. Roasting therefore offers possibilities which are limited by difficulties in practical operation.

A second method of attack is to digest the raw slimes in boiling strong sulphuric acid. This readily dissolves nearly the entire content and yields a very foul solution of sulphates and an impure gold residue. Fortunately silver forms one of the very few insoluble chlorides and the plan would be to precipitate the silver with salt and reduce the chloride to metallic silver.

We have now a plan which would promptly yield the bulk of both the silver and the gold for marketing while leaving the less valuable constituents behind for working up into various other by-products. Such a plan may yet develop commercially but there are again some serious practical problems to be overcome. In the first place a certain amount of flour gold is formed and it is very difficult to keep this away from the silver chloride precipitate. If the latter is not free from gold it has to be parted, incurring corresponding delay and expense. Silver sulphate is not a readily soluble salt and a considerable bulk of valuable liquor has to be handled. The reduction of silver chloride can be done electrolytically or chemically but even that is not complete and the question of small quantities of chloride being volatilized during melting has to be considered.

On the gold side we have a sludge carrying lead and antimony as well as the gold, and this involves fluxes and slags in the refining.

The other elements are collected in a bulky, dilute solution carrying sulphates and chlorides and any simple separation is a chemical problem of no mean order.

SMELTING

Another possibility lies in directly melting the raw slimes in a furnace with separation of slag and matte leaving most of the gold and half to two-thirds of the silver in a doré bullion which can be quickly fined and parted. The slag can be returned to the anode furnace as at present and the matte subjected to some special process.

The direct blowing of this matte in a small Bessemer converter is the most obvious method. We would get a selenious oxide fume and a copper-silver blister as the products, which would be quite satisfactory metallurgically. The difficulty is in the lack of courage to face the probable silver losses. Now that the Cottrell process has been so successfully applied to silver flue losses (Aldrich Transactions American Electrochemical Society, Vol. XXVIII, p. 119) this might be reconsidered.

Another method is to pulverize this matte and leach the values, pre-roasting if desired. This really means leaching out the copper and we have simply rearranged the steps in the original process so as to more promptly release part of the values.

Smelting has the advantage that a fair separation of other impurities is made in concentrated form, easily stored for retreatment.

PARTING

This step is in a very satisfactory state of development and but little improvement in methods is to be looked for.

New York City.

Proposed Large Metallurgical Works for Spain.—At the general meeting of the Sociedad Española de Construcción Naval, recently held at Madrid, the directors proposed and were empowered to proceed with the preliminaries of a scheme for large works to supply the necessary material required by the national arsenals and the shipbuilding industry, such as forgings, castings, shapes, and special steels of every kind and copper, brass, and special bronze articles for which Spain has, until now, been dependent on foreign countries, and in the procuring of which the difficulties are increasing day by day. The aim henceforth will be that ships and war material must be built in Spain entirely of materials produced in the country, for which purpose large works with an annual output worth £1,000,000 are to be established with the technical co-operation of a British group at a cost of about £800,000.—*Iron & Coal Trade Review*, July 13, 1917.

Some Notes on Sulfonating Kettles

By Frederick Pope

In this discussion I will consider the various methods of controlling temperatures in sulfonating kettles, methods of agitation, and forms of kettles.

Sulfonating kettles are made of cast metal, for instance, cast iron or various acid resisting metals such as Duriron, Tantiron, Corrosiron, Buflokast, etc., the ratio of depth to diameter and shape of bottom varying widely according to the service required of the kettle. Kettles are ordinarily discharged either through the bottom or through a permanent or temporary tube inserted through the top, in which case air pressure is used to empty the kettle.

Fig. 1 shows a frequently used type of sulfonating kettle. The kettle itself is made of cast iron. The jacket may be either cast iron, or more often, boiler plate. Such a kettle is useful for such sulfonations as require either no external supply of heat, or a supply of heat at a low temperature.

Usually the source of heat is low pressure steam in the jacket, the steam being admitted through openings around the top of the jacket, and the condensation drawn off through an opening at the bottom.

This type of jacket is used when the source of heat is hot water, or when cooling water is used to control the temperature within the kettle.

When the kettle is heated by low pressure steam, a space of 1 to 2 in. between the outside of the kettle and the inside of the jacket is sufficient, but when hot water is used for heating or cold water for cooling, the space should be at least 4 in. These figures are for medium sized kettles, say in the neighborhood of 4 to 5 ft. in diameter. When either hot or cold water is used, care must be taken that it is introduced at a number of points, and drawn from a number of points to prevent hot or cold streaks in the jacket.

Steam jackets of this sort carefully designed and well built may be used for temperatures up to 130 deg. C. The jacket should be carefully insulated with asbestos or other non-conducting covering.

An example of a kettle of this sort is the one used in the sulfonation of benzol to benzol sulfonic acid, which is heated to a point between 80 deg. and 110 deg. C., depending upon the method used, and is equipped so that water may be admitted into the jacket for cooling in case of overheating.

When a higher temperature than 110 deg. C. is desired, we have a more difficult problem because if we use steam as our source of heat for heating the kettle, higher pressures are necessary, and we have the awkward problem of cylinders of large diameter subject to collapsing pressure from the outside.

A number of methods have been devised for solving this problem. Superheated water is successfully used abroad in place of high pressure steam. Fig. 2 shows one method of designing a kettle for high pressure steam. Here coils of wrought iron pipe are placed in the mold for the kettle, and cast iron is poured around them. It is reported that this construction is successful abroad, but according to available data has never been very successful in this country, the difficulty being the difference of coefficients of expansion between the wrought iron and cast iron. It presents a very at-

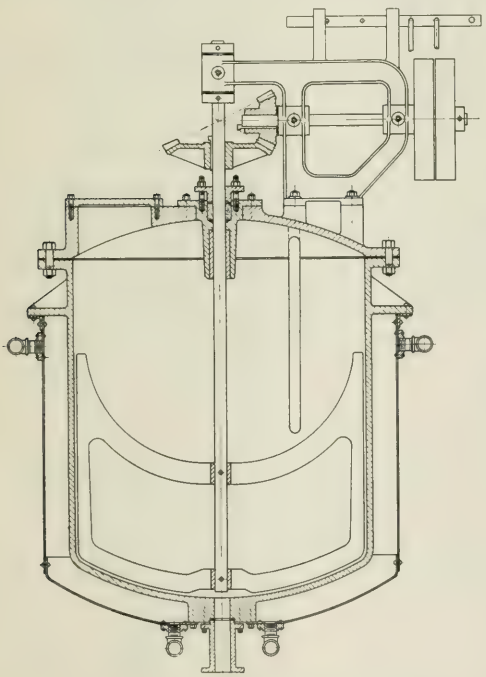


FIG. 1—CAST IRON SULFONATING KETTLE

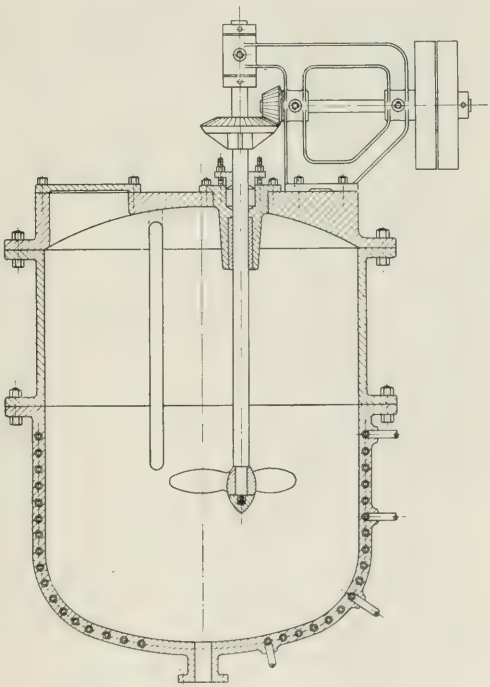


FIG. 2—SULFONATING KETTLE USING HIGH PRESSURE STEAM

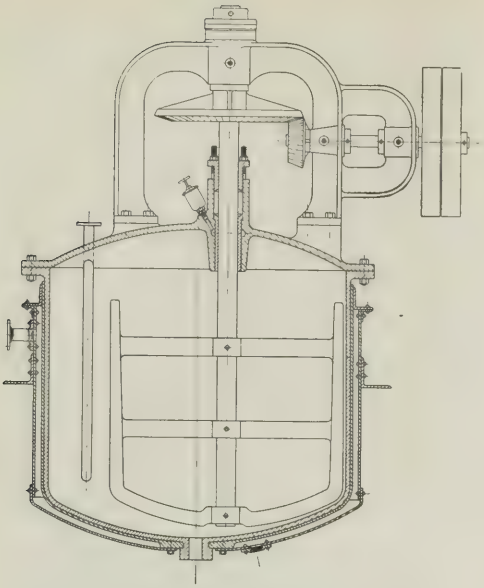


FIG. 3—ANOTHER METHOD OF USING HIGH PRESSURE STEAM

tractive method of heating if it can be worked out.

Another method of heating with high pressure steam is shown in Fig. 3. Steam at 125 lb. per square inch can be used in this jacket, the construction of which is very evident from the drawing. The jacket and inner shell are made of boiler plate, into which a lining of cast iron is poured.

Another method of getting high temperatures is to use superheated steam, the steam being at a low pressure. The objection to this method is the fact that one encounters innumerable well known mechanical difficulties. The objection to superheated steam besides the well known mechanical difficulties is the fact that the more highly steam is superheated, the nearer it approaches a gas, and the less becomes its weight per cubic foot. Both of these decrease its value as a medium of carrying heat.

A perfectly obvious way of obtaining high temperatures in a sulfonating kettle is to discard entirely the jacket and to heat the kettle directly, using preferably gas or oil for fuel, or to heat the kettle in a current of hot gas coming through a checkerwork, the checkerwork tending to give even temperatures, and to the avoiding of sudden changes up or down.

Another way is to surround the kettle with a steel jacket, forming an air bath. This method has been successfully used, but the thermal efficiency is not high.

The last method I wish to discuss for heating a kettle to a high temperature is by the use of some circulating medium, for instance, oil. In such a case we use a kettle similar to the one shown in Fig. 1, the oil entering a number of places in the bottom, and leaving through a number of openings spaced around the top. Such a system as this can easily be understood from Fig. 4 in which *a* is the sulfonating kettle, *b* the heating coil, *c* the circulating pump, *d* the expansion tank, and *e* the reflux condenser. The expansion tank should be equipped with steam heating coil to heat the oil before circulation is attempted. The first time the oil is used, the temperature should be raised gradually, as even the best circulating oil contains some water, which must be driven off before this system will work smoothly.

Temperatures up to 150 deg. C. may be maintained with the mineral oils available without serious deterioration of the oil. If it is desired to maintain a higher temperature than this, the oil circulating system should be provided with a reflux condenser to return to circulation anything that might be driven off from the circulating oil. When the system is equipped with reflux condenser, temperatures up to 250 deg. and even 300 deg. may be maintained.

A standard form of superheater re-arranged so that all the pipes are in series instead of some of them in parallel makes an excellent oil heater. The heater is preferably fired with oil or gas on account of the ease in regulation. This system should be equipped with a recording thermometer. In a well designed oil heating system, it is possible even when running a number of kettles from one heater to maintain the temperature within one or two degrees either way from a given point.

A sulfonating kettle is ordinarily equipped with a thermometer tube extending well into the liquid. It is always desirable to use a recording thermometer in connection with a sulfonating kettle.

A sulfonating kettle must always be provided with a cover to prevent loss of acid through evaporation or the weakening of the acid by abstracting water from the air. The cover may be of cast iron or boiler plate. The joint between the kettle and the cover is usually made either of lead or asbestos, although in some cases

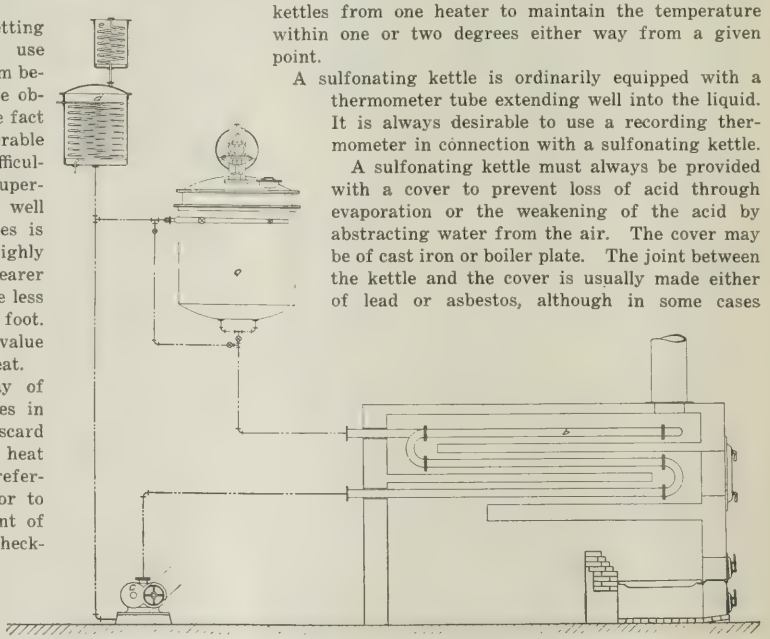


FIG. 4—OIL-HEATING SYSTEM

the cover is simply bolted to the kettle. The cover should have the following openings: A manhole as large as possible up to 12 in. by 15 in. or 14 in. to 15 in. diameter; an opening to admit sulfuric acid; in some cases a pipe connection to admit the material to be sulfonated, as for instance in a phenol plant, an opening for benzol, while in other cases, in making beta naphthol for example, the material to be sulfonated is charged through the manhole. In some instances, it is desirable to have an opening for a pressure gage or other form of manometer. If the kettle is not a bottom discharge, there is either an opening for inserting a temporary tube to the bottom or a permanent tube extending to the bottom, and an opening for compressed air for discharging the charge. It has been proposed to discharge the kettle through a hollow agitator shaft, but this is not recommended. There may be necessary an opening for the escape of fumes or for a condenser.

In the case of many reactions, often in the sulfonation of amino compounds, the reaction mass must be cooled in order to prevent undesired sulfonation of the compound. This cooling may be accomplished by either introducing water into the jacket if possible, or by having closed end pipes of enameled or acid resisting iron extending into the mass, and running cooling water or brine through these pipes.

The apparatus must be designed to meet the requirements of the reagent used. Ordinary pig iron, which is generally used, is not used with fuming acid, since it is quickly corroded by the high temperatures, which are often maintained for hours, in such a way that they accumulate gas in the little hollow spaces of the iron (hydrogen, carbon dioxide, etc.) which may disintegrate the cast iron. Wrought iron is strongly corroded by fuming acid up to 25 per cent free SO_3, at which strength it is again passive.

Various linings may be used. Enamel or lead applied directly to the inside of the kettle, or a chemise of nickel are used. The advantage of a nickel chemise is that when it is used up, it may be withdrawn and replaced by a new one.

Kettles have been built with horizontal stirring devices, but this is not desirable because of the difficulty in keeping the stuffing boxes tight when the shaft is in a bearing in contact with acids. It is also true that a horizontal stirring apparatus requires more power than a vertical one. A slanting stirring device gives uniformly good results, but for some undetermined reason is seldom used. The writer recommends it to the earnest consideration of users of sulfonating kettles.

Nearly all sulfonating kettles are provided with agitators of which there are a number of forms in use. The ordinary "U" type of agitator with the center line of the shaft coinciding with the center line of the kettle as shown in Fig. 3 is a common type, and for many uses very successful. This type of agitator is also used with the center line of the shaft parallel to the center line of the kettle, but a little off center, which gives a better agitation.

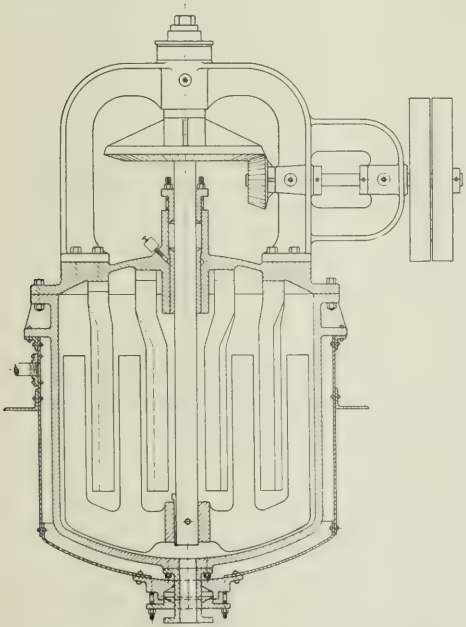


FIG. 5—KETTLE WITH SPECIAL TYPE OF AGITATOR

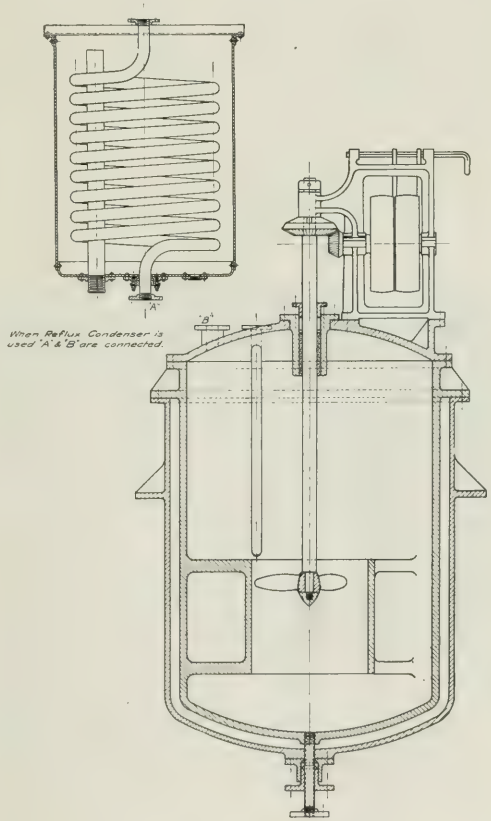


FIG. 6—KETTLE WITH PROPELLER INCLOSED IN TUNNEL

Another type of agitator which is very useful for certain purposes is shown in Fig. 5, which is really an elaboration of the "U" type. It is really a number of "U" type agitators with breakers.

The propeller is largely used as an agitator in a number of different ways, and although it is undoubtedly the ideal agitator under certain conditions, it cannot be used indiscriminately. There is one correct speed for the propeller type of agitator, which depends upon the size and shape of the kettle, size, form and pitch of the propeller, and the liquid in the kettle. A comparatively small variation from this speed will reduce greatly the efficiency of the agitating device. It follows that the propeller type is usually unsuitable in a sulfonating kettle in which the character of the liquid changes in the course of the reaction.

A single propeller is often used. A modification of this, considered by some to be an improvement, is to inclose the propeller in a tunnel, as shown in Fig. 6.

Another arrangement favored by many is two propellers on the same shaft, one propeller throwing in one direction, and the other in the other. Often these propellers have varying pitches. An arrangement of this sort well thought of in England has two propellers working in different directions with different pitches, with side breakers on the inside of the kettle, the shaft carrying the propellers revolving rapidly (250 r.p.m.). This is shown in Fig. 7. In certain work, it is reported to have been very successful.

In the opinion of the writer the best arrangement of the propeller is either one or two propellers; in case two are used, with varying pitches, and throwing in opposite directions, the shaft carrying the propeller or propellers parallel with the center line of the kettle, but a certain distance off center, as shown in Fig. 2.

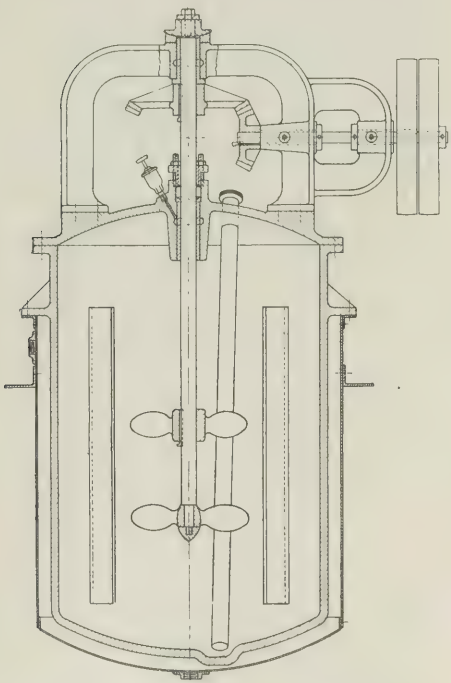


FIG. 7—KETTLE WITH TWO PROPELLERS ON THE SAME CHAIR

There are a number of special types of agitators for particular service used in sulfonating kettles. For instance, there are kettles built in which the shaft carrying one agitator is hollow, another shaft extending through the hole in the shaft carries another agitator revolving in the opposite direction. There are scraper types of agitators for particular purposes. In fact, the desirable type of agitator must be chosen in each case, and can only be determined by experience and study.

In a bottom discharge kettle, the design of the bottom discharge must be carefully considered. Many makers design a sulfonating kettle in which the discharge pipe passes through a stuffing box in the outer jacket and is screwed into the sulfonating kettle. For some uses, this construction is applicable, but often the screw threads are attacked by the acid, the threads in the casting being attacked as well as the threads in the discharge pipe. When the threads in the kettle have been destroyed, troublesome repairs are necessary. It is much better to introduce a spool piece between the kettle and the jacket as shown in Fig. 5. The valve controlling the discharge can be bolted directly to this spool piece.

Another method is to make the discharge pipe of cast iron with a flange cast on either end. The discharge pipe is bolted to the sulfonating kettle, passing through the jacket through a stuffing box. In this case it is necessary that the stuffing box and gland be split.

There has been considerable interest of late in continuous sulfonation, a number of schemes having been devised for the purpose. A step in this direction is sulfonation in two stages, which has been very successful in at least one large works.

Moses, Pope & Messer, Inc.
New York City.

Washington School of Mines.—The School of Mines was given an important place in the reorganization of Washington State College, at Pullman, Wash., by the board of regents at its last meeting and recently announced by President E. O. Holland.

Under the new plan, the mining end becomes one of the eight schools or colleges that comprise this state institution, and Prof. Francis A. Thompson, head of the mining department, becomes dean of the school of mines.

Full facilities will be available for instruction in, and treating ores by, all standard forms of treatment, including leaching, amalgamation, concentration, roasting and smelting. A special laboratory will be devoted to the flotation process.

Endowment of research on a large scale is the form that the memorial to the late Sir William Ramsay is to take. Five hundred thousand dollars is the amount mentioned. The interest on this sum will be devoted to the establishment of fellowships, which will be granted to mature investigators rather than to budding students. Ramsay was the most energetic and daring chemist that England has produced, and he deserves a substantial and generous monument in his remembrance.

Suggested Improvements in the Manufacture of Silica Brick*

By C. E. Nesbitt and M. L. Bell

The study of silica refractories is receiving more and more attention as shown by the increased number of articles appearing in the technical magazines. The published literature so far has dealt mainly with the theoretical study of the raw materials, while the practical side has received very little attention. Theoretical information is of extreme importance, but its importance is negative until put to practical use. The brick manufacturer is not as a rule a man of theoretical training, hence theoretical investigations to be of use to him must be expressed in simple and explicit terms, easily understood. This does not however excuse the maker, who in most cases has been negligent in regard to investigations of the properties and to improvement of his own product. The consumer has also been at fault in that he has not freely co-operated with the maker and informed him wherein the bricks failed. To obtain the best result it is necessary that these three —the investigator, the maker and the consumer— should work together with heartiest co-operation.

In the manufacture of iron and steel, silica brick find their greatest use in the open-hearth furnace. The demand here is for a brick of high refractoriness which does not become soft or plastic at working temperatures. The silica brick fulfills these requirements in that it is refractory and does not yield to compression unless the stress is sufficient to crush it. The ability of silica brick to stand when only a small portion of the original wall is left is well illustrated in the bulkheads. (Fig. 1.) This wall when built is 18 in. thick, but wears away in spots to less than 1 in. in thickness and still the brick retains its place.

In the by-product coke industry the development of the use of silica brick is interesting. Formerly a quartzite brick was used which was made of a mixture of clay and ganister. The object of the quartzite brick was to overcome the shrinkage and settling common to fire brick. Some twelve years ago silica brick were used experimentally in both beehive and by-product ovens. The experiment proved so successful that their use increased rapidly; not only did their expansion make a close, well-fitting joint and overcome settling difficulties, but their better heat conductivity greatly reduced the coking time. (Fig. 2.)

THE MANUFACTURE OF SILICA BRICK

In the manufacture of silica brick in this country the raw material used is quartzite rock commonly known as ganister. The important deposits are found in Huntingdon and Blair Counties of Pennsylvania, Devil's Lake region of Wisconsin, and in Alabama and Colorado. It is essential for high-grade silica brick that the ganister be hard and dense. The rock should analyze about 98 per cent silica, with 1 per cent each of iron and alumina. The raw material is broken to convenient size, dumped into a wet pan, and ground with water and lime. The degree of fineness and the amount of water is left to the judgment of the operator. This is a source of considerable variation, as it will be shown later that the degree of fineness has considerable influence on the strength of the finished brick.

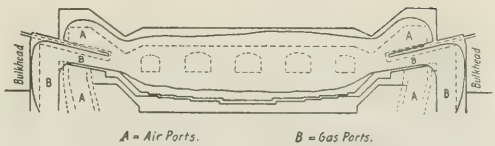


FIG. 1—VERTICAL LINES OF EROSION ON AN OPEN-HEARTH FURNACE

The binder commonly used is lime. Two per cent has been found to give the most satisfactory results. Percentages greater than this lower the refractoriness and decrease the strength of the brick, while percentages below 1½ per cent do not give a satisfactory bond. Binders such as iron, alumina, talc, water glass and other substances have been tried with more or less success.

The amount of water necessary to produce a satisfactorily working mud varies somewhat with the kind of rock used, amount of calcined material present and the method of manufacture. The percentage of moisture present is important. About 10 per cent of available moisture is the proper amount for hand-made brick. Too wet a mud will produce bricks and shapes which distort after being taken from the mold, while too dry a mud is responsible for a number of very serious defects, such as unfilled corners, sponginess, improper slicking, and lack of cohesion, all of which tend to give a finished product of low mechanical strength, susceptible to spall and slag penetration. (Figs. 3 and 4.)

The molding is a very critical point in the manufac-

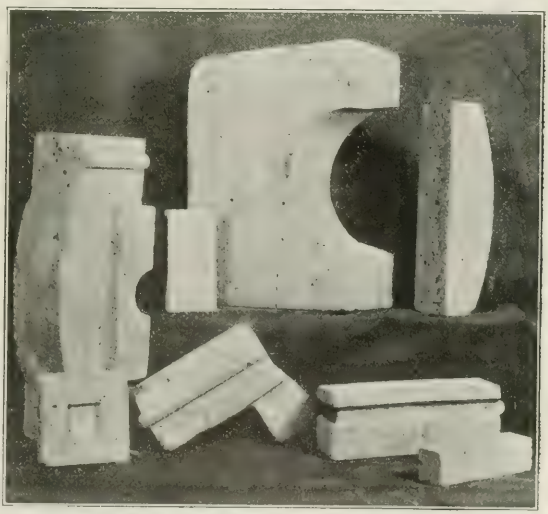


FIG. 2—A FEW DIFFICULT BY-PRODUCT COKE-OVEN SHAPES, ILLUSTRATING SHRINKAGE CRACKS AND CRACKS DUE TO RE-ENTRANT ANGLES—NOTE 9-IN. BRICK IN CENTER FOR RELATIVE SIZE

*A paper presented at the Atlantic City Meeting of the American Society for Testing Materials, June, 1917.

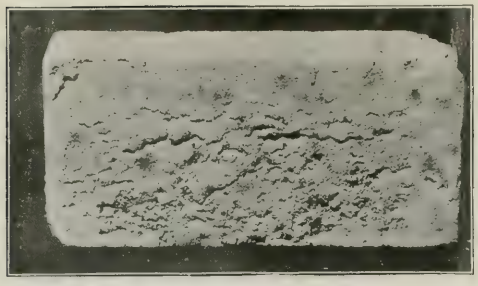


FIG. 3—AN EXAMPLE OF BAD MOLDING, POOR SLICKING, AND SPONGINESS

ture of silica brick. Improper filling of the molds, too wet or too dry mud, improper slicking, dirty palette boards, or careless handling, all contribute their share to the making of a defective product. The defects can largely be eliminated by close inspection and rejection of all but good bricks. As an illustration, bricks were received from a certain company which were poor in quality. The spalling loss was very high, running from 50 to 60 per cent. An investigation was made of the methods at the plant and irregularities of mixing, molding and burning were found. Careful inspection was applied to certain points in the brick manufacture, and to-day this same plant, with no radical change in its general method, is producing bricks much more uniform in shape, strength and appearance, and with a spalling loss of only 25 per cent.

Drying of the brick after molding is accomplished either on a hot floor, heated by steam, or in tunnels heated by hot air from the kilns. Drying on the floor is naturally the slower of the two methods, four to six days being required for 9-in. brick and proportionally longer for larger shapes, while drying in tunnels may be accomplished in eighteen to twenty-four hours. It is important that drying shall be done carefully and thoroughly, for unless the material is bone dry when placed in the kilns fire cracks are apt to result. (Fig. 5.)

The dried brick are set in kilns, which are usually of the down-draft type ranging in capacity from 50,000 to 150,000 bricks. It is important in setting that the bricks shall be true to shape in order that they have a proper bearing and stack well. Green bricks will not sustain a load of much more than 100 lb. per square inch, hence care should be taken not to overload them. Shapes should not be placed near fire boxes nor bear much weight. They are frequently boxed in.

Complete burning requires from ten to fifteen days, with a gradual increase in temperature until cone 16 is attained at least, (1450 deg. C.). The final temperature must be held a sufficient length of time to thoroughly and uniformly heat the entire kiln, which may require anywhere from one to three days, depending on the size of the kiln.

The cooling usually requires about five days and is accomplished by gradually opening the fire holes and doors until the bricks are cool, when they are removed and placed directly on cars or in the stock house.

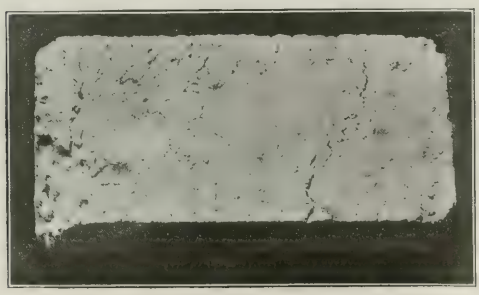


FIG. 4—AN EXAMPLE OF BAD MOLDING AND FIRE CRACKING

TESTS OF SILICA BRICK

With a view to studying the effect of degree of fineness of material and pressure, an experimental series of silica brick was made with these two factors as the only variables. A good quality of Pennsylvania ganister was selected and ground dry in three lots to pass a 12, 8 and 4-mesh screen respectively. To the ground material was then added the water and lime so as to give 9 per cent of moisture and 2 per cent of lime. From each of the above meshes standard 9-in. bricks

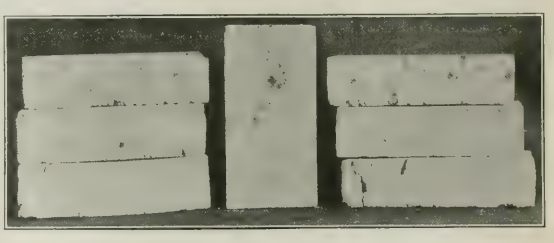


FIG. 5—CHARACTERISTIC FIRE CRACKS

were made on a small hydraulic press at eight different pressures varying from 187 to 2500 lb. per square inch. The bricks were dried, burned and cooled, following regular silica-brick practice, and were then subjected to certain physical tests to determine density, resistance to impact, resistance to spall, resistance to corrosive action of slag and expansion due to heating.[2] A summary of the results is given in Table I, in which the results of the three meshes are averaged according to pressure.

TABLE I—TESTS OF SILICA BRICK, ARRANGED ACCORDING TO PRESSURES

Pressure Under which Bricks were Made, Lb. per Sq. In.	Apparent Specific Gravity	Impact, In.	Percentage Spalled	Slag Penetration, Sq. In.		Expansion, Lin. In. per Ft.
				Open-Hearth Slag	Heating-Furnace Slag	
187	1.50	47	45.5	3.48	2.28	0.155
500	1.58	46	48.3	3.68	2.42	0.155
750	1.59	60	53.2	3.63	2.41	0.158
1000	1.63	65	51.4	3.79	2.42	0.190
1250	1.65	68	47.9	3.65	2.50	0.155
1500	1.66	65	43.6	3.82	2.50	0.160
2000	1.67	67	44.8	3.64	2.45	0.159
2500	1.68	71	42.0	3.72	2.50	0.160

Table II shows the results of the various pressures averaged according to mesh.

[2]The methods used are described in detail in this issue, page 184.

TABLE II—TESTS OF SILICA BRICK, ARRANGED ACCORDING TO MESH

Mesh	Apparent Specific Gravity	Impact, In.	Percentage Spalled	Slag Penetration, Sq. In.		Expansion Lin. In. per Ft
				Open-Hearth Slag	Heating-Furnace Slag	
4	1.66	57	30.4	3.92	2.63	0.156
8	1.62	63	47.6	3.67	2.39	0.159
12	1.58	64	63.2	3.44	2.29	0.159

TABLE III—LOSSES BY SPALLING, EXPRESSED AS PERCENTAGE

Mesh	Pressure Under which Bricks were Made, Lb. per Sq. In.							
	187	500	750	1000	1250	1500	2000	2500
4	21.9	34.9	37.9	38.7	31.4	30.4	19.1	29.1
8	51.6	45.9	62.6	51.0	43.3	34.8	38.3	43.3
12	62.9	64.0	59.2	64.4	69.1	65.8	67.0	53.6

Table I indicates that little is gained by increasing the pressure. Table II, however, shows the importance of the selection of mesh. It will be observed that the strength as indicated by the impact test is greatest with the fine-ground material, while the percentage loss by spalling increases with fineness of mesh. Two very important properties in first-class silica brick are the mechanical strength and resistance to spalling; hence from the data we must select a mesh at the expense of one of these properties. More is gained by the coarse mesh, hence we advocate for silica brick a coarse-ground material. (Fig. 6.)

Table III gives the individual losses by spalling for each pressure and mesh.

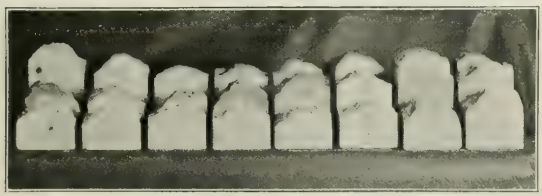


FIG. 6—SPALLING TEST ON EXPERIMENTAL SERIES—NOTE BRICKS IN ILLUSTRATION ARE AVERAGED WITH PRESSURE INCREASING FROM LEFT TO RIGHT AND MESH INCREASING FROM FRONT TO BACK. (TABLES I AND II ARE ARRANGED IN CORRESPONDING ORDER)

The average spalling loss for hand-made silica brick is about 30 per cent. From Table III it will be noted that power-pressed silica brick were made with the same spalling loss from 4-mesh material pressed at 1500 lb. per square inch. These bricks were true to shape, sharp-cornered, dense, and had smooth, marble-like surfaces. Molding defects such as soft corners, sponginess, improper slicking, and lack of cohesion were all eliminated. The prospect of the adoption of power pressing as a step towards better and more uniform silica brick was clearly brought out by this series of tests. The idea of power pressing is not entirely new, yet little has been done in a commercial way. One of the large concerns is now manufacturing brick this way on a commercial basis. The average spalling loss of these bricks is 25 per cent. (Fig. 7.)

In actual service, although well guarded as far as practice and construction will permit, silica brick fail from three primary causes: spalling, crushing and slagging. These cannot be entirely eliminated, but by a deeper study of the manufacturing of brick they can be reduced to a minimum. An ideal brick must be well molded, true to shape, thoroughly bonded, and of good mechanical strength. (Fig. 8.)

A visual inspection of almost any shipment will show at least 20 per cent of defective brick. Six shipments of brick of different brands brought out the fact that 60 per cent of the defects were due to molding, 30 per cent to fire cracks, and 10 per cent to improper setting and irregular shapes. These defects can be largely overcome in the present method of manufacture by careful inspection and rejection of the improperly made bricks at certain points in the manufacture.

The ganister must be carefully selected and sorted; all stock that is soft or which carries considerable iron, clay, sandstone or other foreign matter should be rejected. (Fig. 9.) The ganister selected should be ground to just pass a 4-mesh screen, care being taken to avoid an excessive amount of finely ground material. To insure uniformity, frequent sieve tests of the mud should be made. To secure a sufficient bond, 1.75 to 2 per cent of lime should be used. In order to avoid irregular

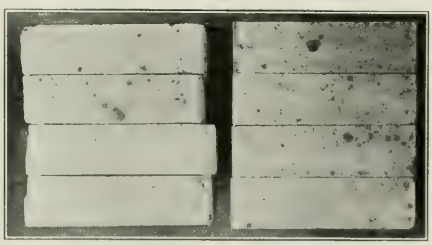


FIG. 7—COMPARISON OF HAND-MADE AND COMMERCIAL POWER-MADE BRICKS NOTE JOINTS

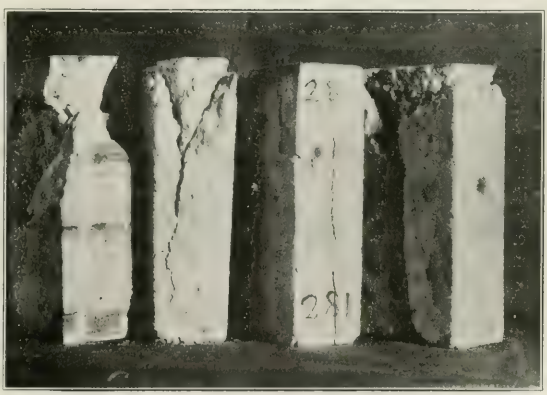


FIG. 8—CHARACTERISTIC CRUSHING TESTS

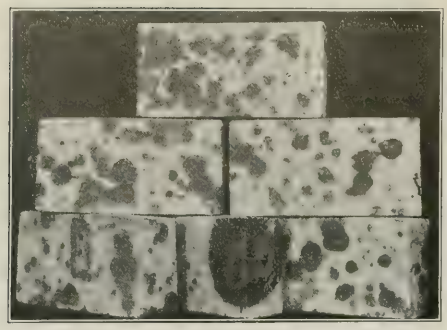


FIG. 9—DEFECTS DUE TO IRON IN RAW MATERIALS

shapes and molding defects, 9 to 11 per cent of water should be used for hand-made bricks and the material should be pounded into the mold. The bricks should be thoroughly dried so as to avoid fire cracks when placed in the kiln. Great care should be used when heating, especially during the first part of the burn, to prevent fire cracking; this applies also to the cooling. The bricks as they are removed from the kiln should be carefully inspected and all bricks showing molding defects, fire cracks and irregular shapes should be rejected.

The consumer should be allowed to inspect the bricks before they are loaded on the car and a place provided for storage of such brick as he may desire to test.

Testing of Refractory Brick

A number of timely recommendations for practice in testing refractory cement were presented at the Atlantic City meeting of the American Society for Testing Materials during June, 1917. These interesting papers and tentative tests are as follows:

Slag Test for Refractory Brick

Early in the study of the physical properties of refractory material in the iron and steel industry, the necessity for a slag test which would give information as to the relative resistance of refractory brick to various slags and fluxes became apparent. To be of use in specifications it was evident that such a test must be rapid, easily performed, and applicable to any kind of brick or slag, and should as far as possible approach conditions similar to those under which the brick is to be used.

As a basis for a test it was decided to place the brick in contact with a certain slag and apply heat until the slag was thoroughly melted. When cold the amount of penetration was observed. In the preliminary work the piling of the slag on the brick was tried, but the results were negative, as the slag ran off the brick as soon as melted, producing no marked penetration. Kaolin rings were tried in hope of confining the slag, but these failed to accomplish their purpose. Pockets were next cut in the brick by chipping. This proved to be successful in confining the slag, but the chipping was too slow and it was difficult to secure uniform cavities. Drilling by means of a press was next resorted to, and uniform pockets were drilled as near as the nature of brick material would permit.

A recommended procedure is as follows: The drill used should be 5/16 in. in diameter, the point should be tapered to include an angle of 150 deg., and the width of the bit should be such as to cut a hole 2½ in. in diameter. Drill a hole ½ in. deep on the sides. The cavity after drilling should be checked up by a standard template, and should conform to the same as nearly as the nature of the material permits. All loose material, dust and cuttings should be carefully removed from each cavity.

The bricks were then heated to testing temperature (1350 deg. C.) and a known quantity of slag was placed in the drilled cavities. After the bricks had become cold they were broken through the slag cavity and examined. Visual examination proved of small value, as results could not be accurately compared; hence it was found necessary to devise some means by which the amount of penetration could be measured. This was accomplished by sawing the brick so that one of the sawed faces accurately bisected the center of the original cavity, and the area of slag penetration thus exposed was then measured by means of a planimeter. The wheel used for sawing the brick is a carborundum wheel, 12 in. in diameter, ⅛ in. thick, 1½ in. diameter of center hole, grit 16, bond NCH, known as a vulcanite wheel.

To standardize the method it became necessary to determine whether the fineness of the slag, the time to which the slag was exposed to the brick, and the amount of slag used in the test had any effect upon the amount of penetration.

To determine the effect of fineness of the slag on the amount of penetration, blast-furnace and heating-furnace slags were selected as representative of the iron and steel industry. Each was ground and separated into two sizes, coarse and fine. The coarse material was that which passed a 40-mesh and remained on a 60-mesh sieve, while the fine was represented by that which passed through a 100-mesh sieve. The slag test was then run in the usual manner on standard hearth and bosh blast-furnace brick. The average results were as follows:

		Penetration, sq. in.
Blast-furnace slag	40 to 60-mesh	1.54
	100-mesh	1.67
Heating-furnace slag	40 to 60-mesh	1.77
	100-mesh	1.72

From the above results it seems that the degree of fineness of the slag does not affect the penetration.

To determine whether the time to which the slag was exposed to the brick, and also whether the amount of slag used in the test affected the penetration, a series of slag tests were run, in which the slag was exposed to the brick at testing temperature for two, four and six hours, with the quantity of slag varying from 35 to 140 g. The results of slag penetration are given in Table I.

From Table I it is shown that the amount of penetration is not increased by keeping the brick in contact with the slag for a longer period than two hours. Preliminary work had shown that one hour would in most cases give complete penetration, so that the adoption of two hours was considered sufficient.

[1]From a paper by C. E. Nesbitt and M. L. Bell and proposed tentative tests by the Committee on Refractories.

TABLE I PENETRATION OF SLAG FOR VARIOUS TIMES OF EXPOSURE AND AMOUNTS OF SLAG

Time of Exposure, Hours	PENETRATION FOR GRAMS OF SLAG USED, SQ. IN. 75	70	105	140
2	0.49	0.58		
2	0.51		0.79	
2	0.45			0.79
4	0.51	0.58		
4	0.43		0.78	
4	0.43			0.83
6	0.46	0.52		
6	0.44		0.70	
6	0.52			0.89
Average	0.45	0.56	0.76	0.84
Area exposed to slag action, sq. in.	5.94	7.07	8.57	9.44
Ratio of exposed area to standard cavity	1.00	1.34	1.44	1.59
Average slag penetration divided by ratio	0.45	0.42	0.53	0.53

It will also be noted that there are two variables, namely, the amount of slag used and the area exposed to slag action. To make the average results comparable these variables must be eliminated. This was accomplished by reducing the area exposed to slag action to a unit figure by dividing the area of the standard cavity (5.94 sq. in.) into each of the other areas (columns 3, 4 and 5 in Table I). The ratio figures thus obtained were divided into the average slag penetration and the results (slag penetration divided by ratio) made comparable. These figures prove that increasing the amount of slag does not affect the slag penetration, when reduced to a unit of area exposed to slag action. The variation in the results are within checking limits and the difference due to the variation in the bricks themselves. For routine work it is recommended that 35 grams of powdered slag (through 40-mesh) should be introduced into the drilled cavity after the brick has been heated to 1350 deg. C., held at that temperature for two hours, and cooled in the furnace.

The question of the advisability of performing a slag test in a drilled pocket as compared to immersing the brick in molten slag was next studied. Bricks from the same shipment were tested, one-half of them by the drilled-pocket method in the usual way, while the others were placed on edge in a refractory tray or shallow box,

TABLE II—RESULTS OF SLAG PENETRATION

Sample	Area No.	IMMERSION METHOD: Slag Penetration, Sq. In.	Slag Contact of Brick, Linear In.	Slag Penetration per Linear Inch of Contact	DRILLED-POCKET METHOD: Slag Penetration, Sq. In.	Slag Contact of Brick, Linear In.	Slag Penetration per Linear Inch of Contact
A	1	5.50	7.0	0.78	1.67	3.5	0.48
	2	1.68	7.0	0.24	1.48	3.5	0.42
	3	2.50	7.0	0.36			
B	1	4.96	8.5	0.58	1.10	3.5	0.31
	2	4.82	8.5	0.55	1.06	3.5	0.30
C	1	0.91	10.0	0.09	0.88	3.5	0.25
	2	0.57	10.0	0.10	0.71	3.5	0.20

in which slag was placed to a depth of 1½ in. All were heated at a uniform rate to 1350 deg. C. and held for one hour. After cooling the bricks were cut at right angles to their length into two or three sections, the cuts being about 1 in. apart. The drilled-pocket samples were cut in the usual way, a second cut being

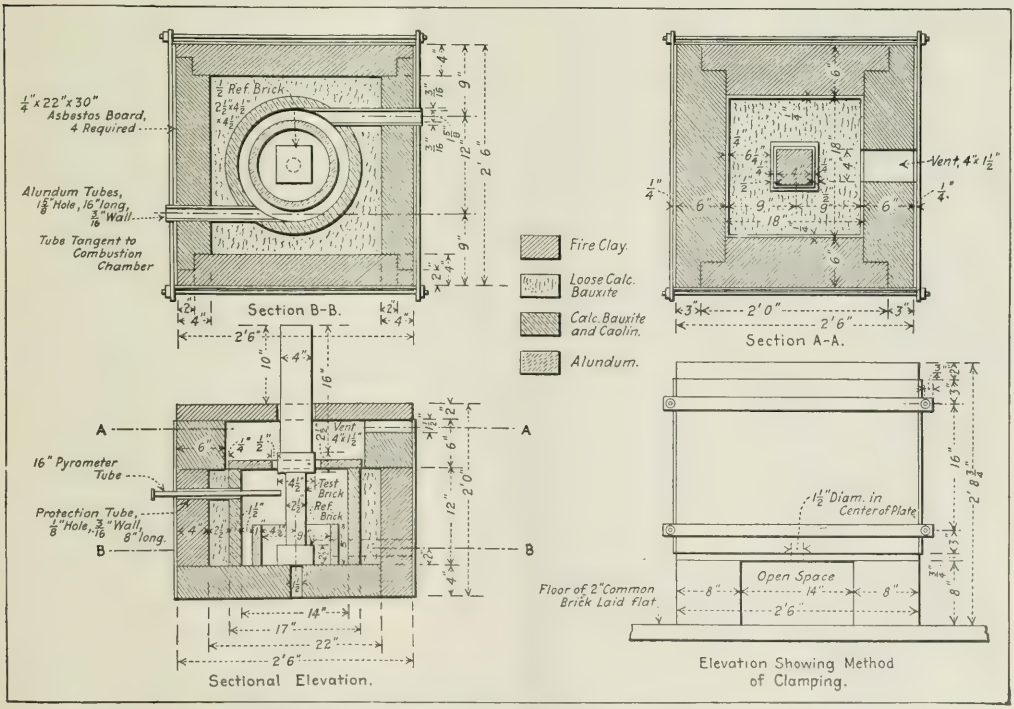


FIG. 1—APPARATUS FOR TESTING REFRACTORY MATERIALS UNDER LOAD AT HIGH TEMPERATURES

then made at right angles to the first. The areas of slag penetration thus exposed were measured with a planimeter; also, the linear inches of slag contact on the surface of the brick were measured. Heating furnace slag was used in this test. Table II gives the results of these tests.

From the results it is evident that greater uniformity of results is obtained by use of the drilled pocket than by immersion. The drilling of pockets to contain the slag is also preferable to the use of large trays to contain the slag, because of economy of space in the furnace.

The drilled-pocket method as at present adopted has several points which recommend it as a standard method. It is very flexible, as cavities, slags, temperature and the amount of slag can be easily changed to correspond to the service conditions under which the bricks are to be used. It is rapid, easily performed, and results are expressed by a definite numerical quantity.

When clay bricks for blast-furnace or similar uses are to be tested, blast-furnace and heating-furnace slags are used. Silica bricks for open-hearth use are tested with open-hearth and heating-furnace slags. The slags used in the development of this test were selected as representing the iron and steel industry and were of the following chemical composition:

	Blast-Furnace Slag	Heating-Furnace Slag	Open-Hearth Slag
Silica (SiO_2), per cent	38.0	35.0	18.4
Iron (Fe), per cent	1.5	44.0	14.5
Manganese (Mn), per cent	1.0	0.5	5.1
Alumina (Al_2O_3), per cent	14.5	0.0	3.8
Lime (CaO), per cent	42.0	1.5	44.1
Magnesia (MgO), per cent	2.0	0.5	6.3
Sulfur (S), per cent	1.0	....	0.4

Refractory Materials Under Load At High Temperatures[2]

The apparatus for testing refractory materials under load at high temperatures consists essentially of a furnace and loading device, constructed in accordance with Figs. 1 and 2.

The furnace is cylindrical in form, 14 in. in internal diameter.

The heating is done with gaseous or oil fuel and compressed air, using not less than two burners located tangentially and so arranged that no flame can impinge upon the test specimen. The burners must be such as will insure a uniform temperature in all parts of the furnace and be under complete control.

The details of the method of loading shown in Fig. 2 should be such as will insure accuracy in the applied load and freedom from eccentric loading, both in the original application and during the testing. It is advantageous to make the cross-beams as light as possible, so that the greater portion of the load may be concentrated in the weights.

The temperature may be measured either with a calibrated platinum-rhodium thermocouple, encased in a double protecting tube with the junction not more than 1 in. from the side or edge of the specimen and approximately opposite the center; or with some form of optical pyrometer which has been calibrated against a thermocouple in the furnace. If the thermocouple is used, the

[2]From tentative tests submitted by Committee on Refractories, A. V. Bleininger, Chairman.

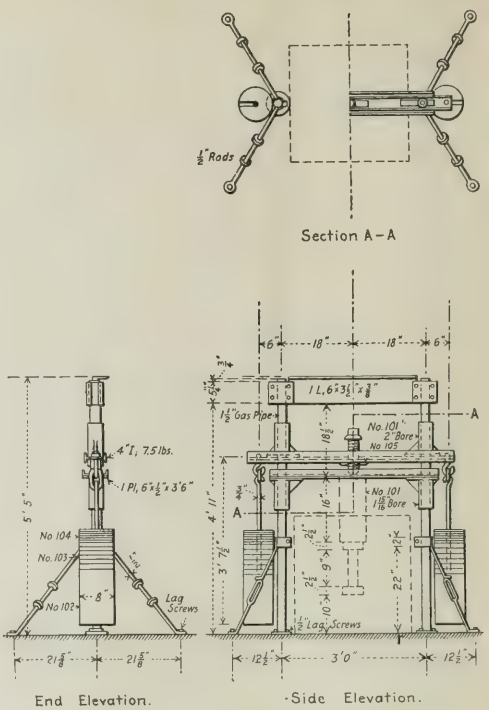


FIG. 2—METHOD OF LOADING

cold-end temperature should be kept constant in melted ice. A recording form of indicator is recommended where possible.

The test specimen consists of a standard 9-in. brick placed vertically on end. In the case of blocks or shapes cut a piece approximately 9 by 4½ by 2½ in., utilizing as far as possible existing plane surfaces. The ends of the specimen should be either ground so that they are parallel and perpendicular to the vertical axis, or if this is impossible should be bedded in a neutral cement, so that the specimen is perpendicular to the base of the furnace. The test specimen should be measured before testing to within ±0.02 in.

The test specimen occupies approximately the center of the furnace and rests on a block of some highly refractory material, having a minimum expansion or contraction. A silicon-carbide brick has been found satisfactory. At the top of the test specimen a block of similar highly refractory material is placed, extending through the furnace top to receive the load.

Table III—Temperatures for Heating at Various Periods

Material	Temperatures, in Deg. Cent., to be Maintained at the Time Intervals Specified					
	1 Hr.	2 Hr.	3 Hr.	4 Hr.	4½ Hr.	6 Hr. End of Test)
Silica material	200	500	900	1350	1500	1500
Fire clay (Heavy duty	500	900	1150	1300	1350	1350
Fire clay (Moderate duty	500	850	1100	1250	1300	1300
Fire clay (Light duty	500	750	950	1050	1100	1100

The method of heating should be in accordance with Table III, which gives the rate and time of heating suggested for different grades of material.

It is recommended that for general purposes a load of 25 lb. per square inch be used. The additional masses required to give the desired loading should be equally distributed on each side of the beam.

At the expiration of six hours the furnace is allowed to cool during a period not less than five hours, before removing the load and examining the test specimen. After the test specimen has cooled to the room temperature, it is remeasured as before, and the change in length recorded and reported as percentage of the original length.

It is recommended that a photograph be made of the specimen before and after testing as yielding valuable information at a minimum time and expense.

Crushing Test[3]

The apparatus may be any of the standard testing machines such as the Olsen, Riehlé, or others.

Operation of Test.—The brick to be tested is first carefully inspected and, if necessary, ground on a carborundum wheel so that both ends are parallel. The brick is then measured, placed in a cold furnace and heated at a uniform rate from atmospheric temperature to 1350 deg. C. (The heating as a convenience is done over night at a uniform rate, not exceeding 260 deg. C. per hour. The total time of heating should in no case be less than six hours.) The final temperature of 1350 deg. C. is maintained for not less than two hours. The brick is then quickly removed from the furnace and placed on end in position on the testing machine. To insure good bearing a thin piece of asbestos board is placed above and below the brick. The machine is started and operated until the brick is crushed. The crushing strength is recorded in pounds per square inch.

A Short History of the Detinning Industry*

The Goldschmidt Detinning Company is the largest concern of the kind in the United States and one of the largest in the world, detinning in excess of 100,000 tons of tin scrap per year and information on the company and its work should prove very interesting.

The tin plate, as practically everybody knows, is really a sheet iron plate coated with tin, the object being to combine the strength of the iron with the rust resisting quality of the tin. The art of covering sheet iron with a thin coating of tin dates back many generations. In fact, as early as the middle ages this art was practiced in the Bohemian Mountains. Later, during the early part of the 17th century the industry spread to Saxony, and about 100 years later it was introduced into Wales, where, in the course of time, it developed into the great tin plate industry which, since the beginning of the 19th century, has grown to be one of the most important branches of British commerce. The production of tin plate in England before the war was about 700,000 tons per year.

This Welsh tin plate industry absolutely controlled the market of the world up to about 1890, and it is rather interesting to know that about 70 per cent of the production was sold to the United States. Since the McKinley act of 1890, however, which placed a high protective tariff on tin plate, it became possible to establish the industry in this country, and it has developed so rapidly that it is larger by far to-day than is the old-established industry of Wales. Before the outbreak of the war over 1,000,000 tons of tin plate was produced per year in the United States, and at the present time the production is estimated at about 1,300,000 tons. It thus appears that tin plate is one of the great staple articles of the world.

Naturally, as the tin plate industry grew to large proportions, the question was raised as to what could be done with the clippings and other scrap which accrue and which accumulate in large quantities. In fact, this problem was considered as far back as the middle of the 19th century, and efforts were made to solve it. The problem was an important one, because unless the tin could be removed from the iron the scrap could not be remelted in puddling or melting furnaces.

The problem at first did not appear to be very difficult, and it was bound to appeal to the inventor, as the can factories were glad to give their tin scrap away for the asking, and even went so far as to pay cartage simply to get rid of it. However promising the problem appeared, and although many ways seemed to be open for the engineer and chemist, it required many decades of study and experimentation before a feasible method was developed which yielded sufficiently valuable results to make it a paying proposition.

It is not possible here to enumerate all the various suggestions which have been offered to solve the problem, the literature in the field is very extensive and hundrds of patents have been taken out in the United States and abroad. Of these but a very few have really been used.

All the processes which have been actually operated may be divided into three general classes, i.e. the mechanical process, the chemical process and the electro-chemical process.

In the mechanical process the effort was made to separate the tin from the iron by means of heat, and more recently by refrigeration. The methods were impractical, however, for one reason or another, but mainly because it was not possible to obtain a thorough separation of the tin from the iron.

Most of the chemical and electro-chemical processes were also failures, either because the acids used attacked the iron as well as the tin or because they would not dissolve the tin sufficiently and left considerable adhering to the iron. It was also found in many cases that the chemicals used were too expensive to make the process an economical one. Three processes, however, have operated successfully and have been in more or less competition with each other for the last forty years, during which time one or another has alternately obtained preponderance due to refinements in that process over the others. These three processes are the electrolytic alkali process, the chlorine process, and the alkali chemical process.

[3] From an appendix to a paper on Improvements in the Manufacture of Silica Brick, by C. E. Nesbitt and M. L. Bell. Other tests for refractory fire-brick have been developed by the same authors, such as impact, spalling, expansion, size and abrasion, which have already been published in Metallurgical and Chemical Engineering, Vol. XV, page 208 (August 15, 1916).

*From *Reactions*, second quarter, 1917.

As far back as the year 1876, Keith* recommended the electrolysis of tin scrap in an alkali solution, while in 1882 Th. Goldschmidt in Germay conducted experiments with a warm solution of caustic soda, using the tin plate as the anode and the iron plate as the cathode. This exceedingly simple idea has been the basis for the further development of the industry, but however simple such a laboratory experiment may be the operation on a commercial scale often results in a great many difficulties, both electrochemical and mechanical, which have to be overcome. These were undoubtedly met with and probably solved in some manner.

One trouble with the process was the fact that the electrolyte had to be watched constantly, and great care had to be exercised in order to thoroughly separate the tin from the iron. The tin is recovered at the cathode in the form of a spongy or finely granulated precipitate, which may be easily removed and melted. The process, therefore, in spite of the care required offers a considerable advantage as it obtains a serviceable iron in one single operation, which may be compressed into solid billets and for which a market can be readily found. It also furnishes a tin sludge which may be easily melted into pig tin. This fact and the apparent, though not real, simplicity of the process caused it to come into quite general use in a comparatively short time, so that up to about 1907 it practically dominated the entire field.

We now come to the chlorine process, which was taken up first in England by Higgins[1] in 1854, and later by Parmalee[2], Seely[3] and Panton[4] in this country. At the time the fact was recognized that it was very essential to use only absolutely dry chlorine gas, which will combine with tin under the development of considerable heat to form anhydrous tetrachloride of tin. This is a heavy liquid which fumes strongly in air and has been known to chemists for about 300 years. In fact, as early as 1605 the chemist Libavius described this product, and ever since that time it has been known under the name of Liquid Fumans Libavii.

When dry chlorine is brought in contact with tin clippings, the chlorine and tin will combine and the anhydrous tetrachloride of tin which is formed will drip off. As chlorine at low temperature does not attack iron the process apparently is very simple. Simple as it may seem, however, it required a number of years to develop the process in such a way that it could be used commercially.

A chlorine detinning plant was established in New York City in 1873, operating according to the Seely patent, but the concern failed when the financial panic of that year brought ruin to so many concerns. Further progress was made in chlorine detinning about 1885, when Lambotte in Brussells started to operate on a large scale with a shaft furnace which was filled with tin scrap from the top, while chlorine gas strongly diluted with air, was introduced at the bottom. This chlorine was combined with the tin from the scrap while the air would carry away the tetrachloride of tin to condensers, where it would be condensed as a watery solution of tetrachloride of tin. The detinned clippings were then removed from the bottom of the furnace and compressed into billets. This process is rather simple in its operation, but the control of the chlorine gas and the tin chloride fumes was difficult and the workmen attending the furnace were greatly annoyed. Furthermore, the detinned clippings could not be entirely detinned and were covered to a certain extent with tetrachloride of tin.

It was not until 1907 that the chlorine detinning process gained real importance as, in that year, Th. Goldschmidt, the pioneers in the detinning industry, abandoned the electrolytic method entirely in favor of the chlorine process which they had developed. Since then it has grown very rapidly, and to-day there are larger quantities of tin scrap and old tin cans detinned with the chlorine process than by all the other processes combined.

Some of the basic conditions of chlorine detinning had been correctly observed by the early experimenters, one of which, and most important, being that all humidity must be excluded in order to avoid a destroying effect on the iron. This is as important to-day as it was then, and it has also been found that the material must be free from all organic substances, such as paper, straw, varnish, etc. The dry tin scrap, therefore, is put into large cylindrical containers either in more or less loose form, or compressed into billets. These containers, after being filled, are closed tight. Dry chlorine is then introduced, and as considerable heat is formed during the combination of tin and chlorine it was early recognized that the heat should not be allowed to raise the temperature of the detinning too high. Means had to be found, therefore, to cool the apparatus and carry off the heat.

In order to achieve a complete detinning the process is carried on under varying pressure so that the chlorine will be forced into every part of the mass of tinned scrap.

After all the tin has combined with the chlorine the liquid tin chloride is removed and the apparatus emptied. The detinned scrap is washed and is then ready to be shipped to the steel mills.

This process possesses considerable advantages over the electrolytic process, as it can be carried on in larger units and the labor charges are therefore materially reduced. The detinning is more thorough and no tin is lost, as in the electrolytic process. The tin is recovered in the form of tetrachloride of tin, which is a valuable chemical product extensively used in the silk dyeing industry. The result is that this process has grown more and more at the expense of the electrolytic and other processes.

We now come to another process which has been touched on previously, namely, detinning by means of alkalies, either alone or in combination with oxidizers. This method was practised at an early stage of the industry, but it did not always remove a sufficient amount of the tin, with the result that a considerable part was left on the iron. It is only within recent years that this process, using alkali and saltpeter, has been developed to a point where the results compare in every respect with the product of the chlorine process.

In this process the scrap is cleaned very carefully and is then placed in a well-heated solution containing

*U. S. Patent 176,658.
[1]English Patent U.766, 1854.
[2]U. S. Patent 102,148.
[3]U. S. Patent 127,375.
[4]U. S. Patent 135,578.

a considerable excess of free alkali and saltpeter or other oxidizer. The mass is then kept at a boiling temperature for several hours during which the tin reacts to form stannate of soda which accumulates in the form of crystals. These crystals ars drawn off and subjected to centrifugal action while the remaining mother lye is diluted with the necessary caustic soda and saltpeter to enable it to be used again in the same way as the original solution.

The stannate of soda is subjected to further treatment by dissolving in water and precipitating oxide of tin by means of bicarbonate of sodium. It should be borne in mind that the alkali used in this process is always recovered and used over and over so that only a very small loss results. The saltpeter is also recovered at the end of the operation with the exception of the amount required for the oxidation of the tin.

The tin oxide obtained in this process is used extensively as a coloring matter in the enamel industry or is smelted in reverberatory furnaces to form pig tin of very high quality.

The Goldschmidt Detinning Company uses this process as well as the chlorine process in its various plants and its output therefore in addition to detinned scrap comprises large amounts of tetrachloride of tin and pig tin of a purity which in every respect is the equal of Straits tin. The company recovers every year the equivalent of almost 2000 gross tons of metallic tin.

Synopsis of Recent Metallurgical and Chemical Literature

Radium

Radium Luminous Compounds.—The discussion of a paper on investigations of radium luminous compounds read at a meeting of the Physical Society of London by C. C. PATERSON, J. W. T. WALSH and W. F. HIGGINS is given in *The Chemical Trade Journal* and *Chemical Engineer* for June 16, 1917.

The paper contained the results of measurements made on various samples of radium luminous compounds during the last two years. Determinations of the brightness of the compound in powder form and when made up into paint, and also after the application of the paint to instrument dials, were carried out, and curves were given showing the rates of decay of luminosity. The radium contents of the compounds were determined by comparison of their γ-ray activities with that of a preparation of pure radium bromide, which is periodically compared with the British radium standard. The various precautions which have to be observed and the corrections which have to be applied in making the various determinations were explained, and the considerations which should govern the proportion of radium employed for practical purposes were discussed.

In the discussion which followed Mr. F. H. Glew said the difference between some of Marsden's results and those of Dewar and Crookes had been attributed to some difference in the zinc sulphide employed; he could state that the sulphide supplied to the National Physical Laboratory was of different origin from either of these. Before the war we were almost entirely dependent on foreign sources for the supply of these materials, but we are now quite self-supporting. In Marsden's work the inside of the tube was completely coated with sulphide, so that the effects were observed by light transmitted through the material. It was better to paint only one-half of the tube, so that the inner surface, which was exposed to the bombardment, could be directly observed. It was singular that specimens prepared by the dry and wet methods should be so similar in their properties after only four days, for in the dry method the emanation and all its products are retained.

Dr. H. S. Allen asked if the zinc sulphide employed was wholly crystalline or partially amorphous. An investigation of its physical condition would be useful.

Mr. J. S. Dow said the figures for the absolute brightness were what he would have expected. He was doubtful of the possibility of expressing the brightness accurately; consistent results could be obtained, but they did not represent exactly what the eye saw. For instance, zinc sulphide and cadmium sulphide may be equally bright a few inches away, but the former will look much brighter at a distance. Had the authors noticed any change of color as the compound got older? He thought it got greener as it aged. The initial rise in the luminosity curves for the weaker materials seemed greater than could be explained by the lower rate of decay.

Dr. Levy said he had found the luminosity of different samples of zinc sulphide to vary perceptibly in tint when stimulated by daylight, but had not noticed this with α-ray stimulation. In his experience, if a sample of sulphide gave good results when stimulated by daylight, it would also be good when stimulated by radium. The reverse did not hold, however, as a specimen might be poor with daylight, but good with radium excitation.

Mr. Walsh, in reply, said that to detect change of color with age would have been difficult in their experiments, because of the continuous decrease in luminosity. They had detected differences in color in samples sent by different makers, but were unaware whether these were from the same source, or made in the same way. They had no data on the relation between daylight and radium excitation, and Dr. Levy's remarks were of great interest.

Iron and Steel

Sulphur as a Component of Furnace Slag.—A very interesting article on the mentioned subject was published in *Blast Furnace and Steel Plant* of July, 1917, by WALLACE G. IMHOFF. As is well known, sulphur occurs in slags in three forms, first, as combined sulphur in the form of calcium sulphide, second, free sulphur held in solution in the slag, and third, sublimated sulphur, the result of an excess of sulphur in the burden.

The sulphur in a furnace charge is mainly in the ore and coke while only small amounts are found in the flux. With lake ores the sulphur going into the furnace will fall within the limit of 1½ per cent, while furnaces, and especially merchant furnaces, with high sulphur coke and pyrites cinders in the burden will run as high as 6 and even 8 per cent in sulphur.

The author cites two examples, figuring in one case the amount of lime required to slag a high percentage of sulphur and in the other where the percentage of sulphur is lower. Careful regulation of the lime is essential since most of this sulphur is eliminated in the slag, although some is carried out by the furnace gases.

In the second example the writer shows the effect of excess lime on the furnace operation. The excess limestone lowers the temperature of the furnace, fluxes the silica, and absorbs the silicon normally entering the iron. Thus as conditions grow worse, and the furnace gets cooler, the silicon content of the iron is lowered, and the sulphur in the iron increases. This accounts for irons extremely low in silicon and high in sulphur resulting when a furnace cools off from being "overlimed." Very often in practice more stone is added as the sulphur in the iron rises, only making the conditions more extreme and resulting in the formation of a very infusible slag: a slag which will at times fill the bottom of the furnace, freezing in the bosh and often terminating in a complete shutdown.

The largest amounts of calcium sulphide are found in foundry-iron slags, which as a rule are high in alumina. The author states that the alumina fluxes the bulk of the silica, while the lime fluxes the sulphur and only a small proportion of the silica. These foundry-iron slags under normal conditions usually show a blue color due to the aluminium silicate. As soon as the furnace gets cool the slag becomes glassy due to silica going into the slag as such. If the furnace is permitted to get still colder, lime silicates will be formed, when the slag is creamy white in color. Then the iron will show an increase in sulphur content, as is shown in Fig. 1, below. A hot furnace working a slag heavily oversatu-

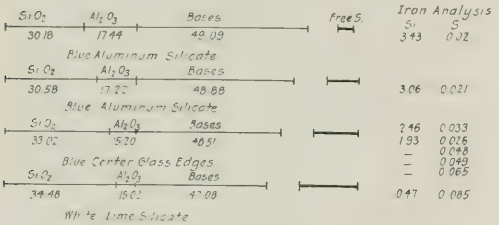


FIG. 1—RELATION OF SLAG COMPOSITION TO SULPHUR IN IRON

rated with calcium sulphide and a high-sulphur burden produces a very heavy, smoky gas, giving rise to a white deposit near the tuyeres. Some of this deposit was analyzed and found to contain 4.20 per cent CaO and 10.73 per cent sulphur. Analyses of slags drawn from such furnaces seem to indicate that these oversaturated slags give rise to such fogs on reaching the atmosphere.

Indirectly calcium sulphide effects the condition of the carbon in the pig iron. When the furnace is working with very heavy lime, a hot bottom and high combined sulphur, the cast house is generally filled with graphitic carbon. This indicates that the formation of calcium sulphide in the slag has a tendency to promote the formation of graphite in the pig iron. The large amount of graphitic carbon in the iron makes the product extremely dry and mushy. Other effects of a hot furnace and heavy lime are: slow working and low fusion zone. The latter is due to the formation of large amounts of combined sulphur.

The author then gives a discussion of basic slags and slags obtained with foundry iron. He illustrates the heating value of the gases obtained in both instances and explains why basic-iron slags generally show less combined sulphur than do the foundry-iron slags. He then states that it is very seldom that all the sulphur present in slags is in the combined form. Some always occurs in the free state and it may be observed in any gas cavities. The foundry-iron slags very high in aluminium which are solid, dry, dense, and grainy are those carrying the largest percentage of combined sulphur. The average basic slag contains less than 1.75 per cent sulphur and the average foundry-iron slag varies between 1.60 per cent and 2.50 per cent of combined sulphur. The combined sulphur depends mainly on the total sulphur entering the furnace, the position of the fusion zone, the hearth temperature, and the slag volume.

The relation of the sulphur in the slag to the slag volume is as follows: Assuming the total sulphur going into the furnace to be practically constant and all other furnace conditions remaining the same, the sulphur content of the slag will be inversely proportional to the slag volume.

Quantitative Determination of Air Dust.—In the *Heating and Ventilating Magazine* for June, 1917, E. Vernon Hill of the Department of Public Health, Chicago, Ill., gives a review of the various methods devised for the determination of the number of dust particles in air, discusses the difficulties encountered and describes types of dust counters developed by him. The latest of these consists essentially of an exhaust pump of known capacity for handling the air and a small capsule or shell affixed to the inlet of the pump, carrying a cover glass, coated with adhesive material for catching and retaining the dust. The author's first experiments in this line were made by drawing a quantity of air into a syringe and forcing it out against a slide covered with adhesive material and counting the number of particles with a microscope. In using this method he found a serious source of error in the retention of dust particles in the barrel of the pump. A device was, therefore, arranged to carry the cover slip on the interior of the pump directly beneath the intake nozzle. With this arrangement the dust was projected against the adhesive material before coming in contact with the interior of the pump.

This was the first instrument developed in the long series of tests with which a consistent and practical determination could be made. In developing the idea just described the next step was to find some means of calibrating the instrument. It was evident that all of the dust projected against the adhesive plate was not retained, some must of necessity escape. A number of capsules were therefore constructed as a separate part of the instrument and designed them in such a way that one could be superimposed upon the other and the air sample drawn through them in series. By experiment it was found that with six such capsules under ordinary or moderately extreme conditions of air dustiness no dust was found in the last capsule. Counts were then made of the samples in the consecutive capsules and a percentage determination arrived at for the amount retained by the first capsule. In routine tests with the instrument, therefore, it is only necessary to use one capsule and correct the result by the factor given for the nature of the work in hand. This for ordinary tests is 62 per cent. The author states that it is not only possible to accurately deter-

mine the number of dust particles, but a study of the kind and character of the dust under observation is often instructive and valuable. This feature greatly enhances the value of the method and makes the work extremely interesting. Counted by this method the particles in clean, outdoor air average from 500 to 1500 per cubic feet. In a mechanically-ventilated school room, without air washers or other air cleaning device, from 10,000 to 30,000. It is also a practical method for testing the efficiency of air washers. For this purpose a "Y" connection is used on the pump and two capsules used simultaneously, one at the proximal and one at the distal end of the washer, connections being made to the pump with rubber tubing.

Some experimental results obtained by two students of the Armour Institute of Technology in work of this kind are of interest. Messrs. Otto Armpach and E. W. Haines made the tests in preparing their graduation theses. The tests were conducted during March and April of the present year on a Webster air washer furnished by Wm. G. Braemer, then manager of the air conditioning department of Warren, Webster & Co., in the experimental laboratory of the Ventilation Division of the Chicago Health Department.

QUANTITATIVE DETERMINATIONS OF VARIOUS KINDS OF DUST REMOVED BY AN AIR WASHER

	Medium	Heavy
Lamp black	89.4	91.2
Rubber dust	90	92.3
Street dust	96.2	98.2
Wood dust	96.5	99.2
Grain dust	98.5	99.2
Rattler dust	99.5	99.7

The "medium" and "heavy" at the head of the two columns refer to the amount of dust that was liberated in vicinity of the intake of the washer. These are the only tests of this character that the author knows of in the literature of air conditioning work.

A statement previously advanced by the author is brought out clearly in these tests, viz., that the per cent of efficiency in dust removal of an air washer increases directly with the amount of dust entering the washer. In every instance these tests show the per cent of removal higher when the quantity is "heavy." The author emphasizes the statement: that with any method of dust determination the results are relative only, they cannot be absolute. This is due to the fact that a considerable number of the minute dust particles that are always present are not caught in the liquid when dust is collected by bubbling through water but pass through with the bubbles, the amount retained increasing as the size of the bubbles and velocity of air passing through the liquid decreases. He has repeatedly drawn room air through a Drechsel bottle with a 3-in. water seal and counted as high as 7000 small particles per cubic foot that were not retained in the water. Air passed through four wash bottles in series still gives a light beam with the diffractoscope. On the other hand, while much of the dust that passes through the wash bottle can be collected and counted with this latest dust counter, even with this instrument some particles are so small that the magnification used does not reveal their presence.

Recent Metallurgical and Chemical Patents

Iron and Steel

High-Speed Steel.—An alloy high-speed tool steel of the tungsten-chromium-vanadium type is patented by James H. Parker of Reading, Pa., and B. H. De Long of Springmont, Pa. (assigned to Carpenter Steel Company of Reading, Pa.). The alloy has a high proportion of cobalt and has approximately the following composition:

	Per Cent
Carbon	0.35
Vanadium	2.00
Chromium	3.50
Tungsten	12.00
Cobalt	30.00
Iron	52.15
	100.00

The proportions of iron and cobalt correspond with the eutectic proportions. It is claimed that the alloy will give maximum service with increase of possible speed and cut. (1,233,118, July 10, 1917.)

High Speed Tool Steel Alloy.—A patent issued to Radclyffe Furness of Jenkintown, Pa. (assignor to the Midvale Steel Company), states that if a certain amount of both cobalt and tungsten be added to an ordinary high-speed tool steel, containing tungsten, chromium and vanadium, a substantial increase in cutting efficiency is attained. The amount of uranium is so small that it cannot be said to replace the known high-speed tool steel additions, its presence even in apparently negligible proportion improving the efficiency of the tools.

	Preferred Analysis, Per Cent	Limiting Proportions, Per Cent
Cobalt	4.5	3.0 to 7.0
Uranium	0.7	0.1 to 2.0
Tungsten	13.5	12.0 to 20.0
Chromium	3.5	2.0 to 6.0
Vanadium	1.5	0.5 to 2.0
Carbon	0.7	0.5 to 0.9

(1,233,862, July 17, 1917.)

Deoxidizer for Steel Baths.—J. I. Bronn of Rombach, Germany (assignor one-half to Rombacher Hüttenwerke), patents a substitute for ferromanganese or other expensive de-oxidizers to produce a workable steel. The oxygen containing iron baths obtained at the end of the Bessemer or open-hearth processes are deoxidized with a molten pig iron high in phosphorus. If a calculated amount of phorphorus is used to react with the oxygen in the bath, no substantial impurification results. Under certain circumstances it may be advisable to charge an excess of phosphorus, which can easily be removed by a short refining without appreciably reoxidizing the metal. The deoxidizing effect of the addition of Thomas pig iron to the converter charge appears from the following comparative data relating to working with Thomas pig iron containing 0.45 per cent silicon, 1.20 per cent manganese, 1.85 per cent phosphorus and 3.5 per cent carbon.

	Mn, Per Cent	P, Per Cent	C, Per Cent
Iron bath at end of blow	0.19	0.045	0.05
After addition of Thomas pig-iron	0.25	0.085	0.07

It is advisable to add the molten phosphorus containing pig iron in the converter after skimming in order to

improve the intermixing. In connection with the open-hearth furnace the bath is refined as usual and the iron rich in phosphorus added in the molten condition when the furnace charge is nearly finished. Care is to be taken that the slag layer on the iron bath is not very high in phosphorus and that it is in as thin liquid condition as possible. The following comparative data show the effect of the addition of Thomas pig iron:

	Mn. Per Cent	P. Per Cent	C. Per Cent
The furnace charge (33 tons) after refining contained	0.26	0.030	0.10
The Thomas pig iron addition (1500 kg.) contained	1.75	2.78	3.5
The deoxidized bath contained	0.43	0.062	0.15

The bath shows an increase in manganese over the amount of manganese contained in the pig iron addition, namely:

The bath contained	$330 \times 0.26 = 85.8$ kg.
And the addition	$15 \times 1.75 = 26.1$ kg.
This makes together	111.9 kg.

whereas the bath contained as above stated 0.43 per cent manganese or 148 kg., so that an increase of 36.1 kg. manganese has taken place. The phosphorus on the contrary shows a considerable decrease, namely:

The charge contained	$330 \times 0.03 = 9.9$ kg.
The addition	$15 \times 2.78 = 41.8$ kg.
This makes together	51.7 kg.

whereas the bath contained $345 \times 0.062 = 21.3$ kg., so that a decrease in phosphorus of 30.4 kg. has taken place which have been used for deoxidizing purposes. These data relate to the pig and ore process. Similar results are obtained in connection with the pig and scrap process. If compared with the usual deoxidation process with ferromanganese alone the deoxidation with pig iron (Thomas pig iron) rich in phosphorus results in saving 2 kg. metallic manganese or 4 kg. ferromanganese with 50 per cent of manganese for each ton of steel. (1,233,970, July 17, 1917.)

Zinc Distillation

Condenser to Produce Pure Zinc.—A patent issued to A. J. F. de Bavay, Kew, Victoria, Australia, covers a proposed construction of condenser where pure zinc may be attained by the separation of other volatile metals by passing the complex distillate seriatum through a series of differentially heated liquid condensates. In practice, the condenser B is just charged with the proper amount of molten zinc sealing the downwardly projecting baffles B^2, and a reducing gas containing zinc vapor drawn from the furnace A by the suction of the fan F. Three compartments are shown, separated by the upwardly projecting baffles B^1. These baffles are formed with a groove B^2, with the near side slightly lower than the other, the groove being connected to a pipe B^4 (Fig. 1) dipping into a pot D of molten zinc of sufficient head required by the fan suction. In this way a constant level of the bath is maintained, zinc being ladled from D from time to time as it accumulates. Each compartment has also a drain B^6. The temperature in the various chambers is above the melting point of zinc, and is differentially decreased toward the fan. The metallic vapor is drawn through the molten zinc, passing from one compartment to the other, being practically freed from fume at the exit. The impurity lead is mostly collected in the first compartment, while the molten zinc in the succeeding chambers is differentially free from other impurities, and cadmium-zinc may be collected in the last condenser. (1,233,652, July 17, 1917.)

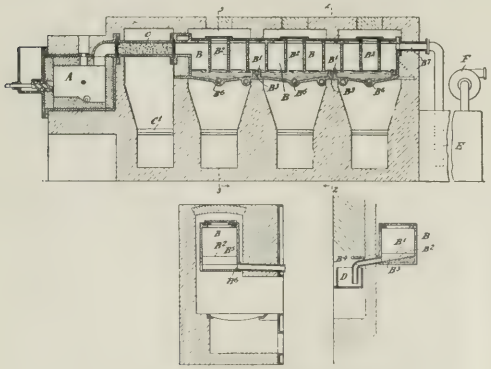


FIG. 1—ZINC DISTILLATION FURNACE

Glass

Quartz-Glass-Making Machine.—A machine for making tubes, flasks, etc., of quartz glass is patented by Armin Frost of New York, N. Y. It consists of a cylindrical melting chamber having a double wall, the space between the walls being filled with the same material that the vessels are to be made from, in order to prevent radiation and loss of heat. The melting chamber is filled with the charge and heated by a graphite rod passing through the center of the chamber and connected at each end with a source of current. When the annular core surrounding the rod is melted, the current is turned off and the furnace withdrawn from the upper electrode by lowering the elevator upon which the melting chamber rests.

In the opening at the top of the tube formed by the core, after the graphite rod has been withdrawn, is inserted a blowpipe, the tube being tightly closed upon it, so that no air can escape and the desired thickness of the tube attained by the proper lowering of the elevator, taken in connection with the admission of compressed air, causing the tube to be formed uniformly thick and straight.

The molten glass still remaining on the electrode in the melting chamber is let down by the elevator and inclosed in molds of the proper shape, the glass being forced outwardly by the compressed air entering through the pipe. (1,232,785, July 10, 1917.)

Thermostat.—The accompanying drawing represents a vertical central section through the apparatus, some of the parts being shown in side elevation, invented by Niels Bendixen of Copenhagen, Denmark, which operates as follows: By a swift rise of the temperature the fluid in the receptacle 4 is vaporized, whereby the pressure of the vapor acts upon the diaphragm 6, the pin 8, and one end of the spring 12, so that the latter moves upward. The contact 14 thereby will come in touch with contact 15 and close an electrical circuit through the wire 22, the stud 2, the spring 12, the contacts 14 and 15, the spring 13, the stud 3 and the wire 23, thereby operating the alarm bell or the like, which is inserted in the circuit. The fluid in the receptacle 5 is only slightly influenced by the sudden rise of the tem-

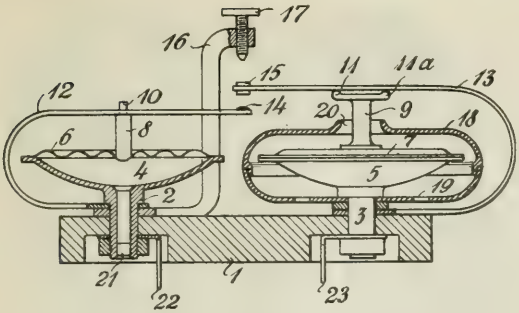


FIG. 2—CROSS-SECTION OF THERMOSTAT

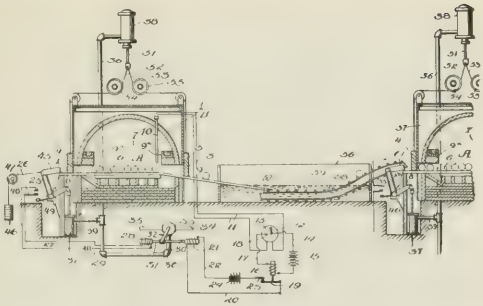


FIG. 3—AUTOMATIC HEAT-TREATING FURNACE

perature, because this receptacle is protected by the case 18, so that the spring 13 and the contact 15 remain in almost unaltered position. By a slow rise of the temperature the receptacle 5 will be heated almost as swiftly as the receptacle 4, the air circulating through the openings 19 and 20. The contacts 14 and 15 will therefore both move upward, but without touching each other. When the rise of the temperature has reached a certain height, the contact 15 will touch the screw 17, and a circuit is then closed through the wire 22, the stud 2, the rod 16, the screw 17, the contact 15, the spring 13, the stud 3 and the wire 23. Of considerable importance to the invention is the particular shape of the pin 9. When the spring 13 is in its central position—as shown in the drawing—it is touched by both bifurcations 11 and 11^a. If the temperature rises, so that the spring 13 is moved upward, it is only touched by the point 11^a, and the speed of the contact 15 is thereby increased. If the temperature is lowered, so that the spring 13 moves downward, the arm of the lever is altered, so that the speed of the contact 15 decreases. This arrangement is very advantageous for preventing errors which may arise on account of the diaphragms not being manufactured quite similarly and therefore not moving with the same speed. (1,233,746, July 17, 1917.)

Heat Treating

Automatic Heat-Treating Furnace.—The continuous pusher-type furnaces mentioned in our issue of July 15, 1917 (Vol. XVII, page 91), have been patented by T. F. Baily and F. T. Cope, assignors to the Electric Furnace Company. The operation is as follows: The billets A are placed one at a time upon the extension 8 of the billet support. As the temperature in the rear end of the heating chamber 7 adjacent the thermocouple 10 reaches the proper degree, the thermocouple moves the arm 13 into engagement with the contact plate 18 closing the relay 16, thus closing the circuit through the solenoid 21 (shown in Fig. 3). The arm 32 is drawn toward said solenoid, connecting the pipe 36 with the water supply. The water operates the pistons in the cylinders 37 and 38, opening the doors of the furnace and pushing the billet which has been placed upon the outside of the door into the heating chamber against the other billets, moving all of them forward. The billet adjacent the door 5, being heated to the proper degree, is pushed from the furnace down the inclined chute 9 into the quenching trough, where it is properly quenched and picked up by the continuously operating endless carrier 58, which carries it upwardly and deposits it upon the billet support of the annealing furnace 57, from where the billet is carried through the annealing furnace in the same manner in which it has been moved through the hardening furnace, the mechanism connected with the annealing furnace operating in the same manner. As the finger 49 comes into contact with the pivoted arm 26, it moves the arm into contact with the contact plate 25, closing the circuit through the solenoid 28. The temperature within the heating chamber of the furnace 1 will by this time have been lowered sufficiently to cause the arm 13 of the pyrometer to move out of contact with the contact point 18, thus breaking the circuit to the relay 16 and to the solenoid 21. The armature of the solenoid 28 will then be operated, moving the arm 32 back into the original position connecting the pipe 36 with the discharge. The weight of the doors will then cause them to close and the counterweight 46 will bring the pusher back to the normal position. (1,234,257, July 24, 1917.)

Binding Material for Briquettes.—A binding material and the method of preparation is invented by Walther Mathesius, Berlin-Nikolassee, Germany. It is based upon the fact that finely pulverized iron oxide and hydroxide will enter into the molecule of free lime or alumino silicates containing a high percentage of lime, forming ferroalumina silicates of lime at temperatures below the temperature of sintering, after which heating the material is still easy to pulverize. The resulting substance on being mixed with further iron ore or iron oxide bearing material, moistened or molded, will agglomerate most perfectly and furnish excellent stable briquettes. (1,233,384, July 17, 1917.)

Conditions in the Abrasive Industry

Col. P. R. Hawkins, of the Norton Company, Worcester, Mass., has supplied the following statement regarding conditions in the abrasive industry to Maurice R. Scharff, executive secretary in Washington of the Technology Clubs Associated.

"We wish to bring to your attention the probable shortage in abrasives, grinding wheels and grinding machinery necessary to manufacture the large quantity of munitions and other supplies required by the United States Government.

"Imports of emery have practically ceased during recent years so that the grinding wheel industry is dependent upon artificial abrasives. These are manufactured from bauxite and carbide of silicon. The leading

and perhaps best known abrasive manufactured from bauxite is Alundum, and Crystolon and Carborundum are examples of those made of carbide of silicon.

"There is a great shortage of cars necessary for the shipment of bauxite from the mines in Arkansas to the places where abrasives are manufactured; the power supply at Niagara Falls, where the important abrasive plants are situated, is likely to be inadequate; we cannot obtain sufficient alumina to make the necessary amount of white alundum, a special abrasive used principally for munitions grinding wheels, and if the draft should to-day take all the men registered in our works we would lose fully 45 per cent of our organization. These are some of the problems which confront abrasive manufacturers at the present time. Norton Company, the largest manufacturer of grinding wheels in this country, is doing what it can to meet these conditions, but the situation should be thoroughly understood by those who are working in the interests of the Government.

"We have the example of England which did not appreciate the situation with regard to grinding wheels and found itself in a very serious position on account of the lack of wheels for grinding shells, gun barrels and other necessary munitions work. The Munitions Board of Great Britain finally sent representatives to this country and we, among others, were very urgently appealed to to help relieve the situation, which we did to the greatest possible extent. We expect a similar condition to occur in this country and everything possible should be done to anticipate the shortage."

Washing Filtercloths

An interesting machine for washing filter cloths is made by the Clenzall Machines Company of America, St. Louis, Mo., under the name of the "Clenzall" washing machine. An illustration of this machine is shown in Fig. 1.

The apparatus consists in its essential parts of an outer case and an inner drum. The inner drum is

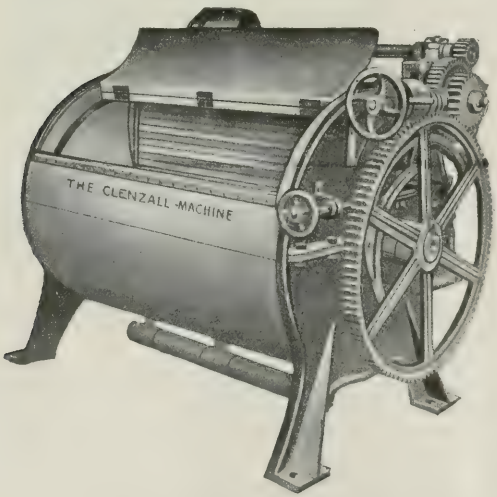
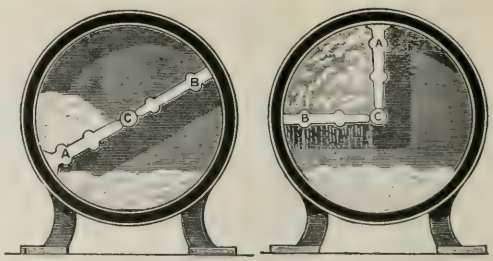


FIG. 1—GENERAL VIEW OF MACHINE FOR WASHING FILTER CLOTHS



FIGS. 2 AND 3—INTERIOR VIEWS OF MACHINE

divided into two compartments by a diaphragm, the upper half of which *A* is mounted on shaft *C* and is held in position by springs fixed to the outer case, while the lower half *B* is fixed to and moves with the inner drum.

The machine is loaded on both sides of the diaphragm as shown in Fig. 2 and being set in motion, the cloths on one side are lifted out of the washing liquor while those on the other side spread out in and absorb the liquor, as shown. During this part of the operation the diaphragm is fixed in a straight line, thus dividing the drum into two equal compartments.

When in action, the inner drum never makes a complete revolution, but only moves through three-quarters of a circle. This insures the rubbing action necessary for a superficial washing and prepares the cloths for the squeezing action which takes place later.

After this rubbing action has gone on for a few minutes, the clutch is altered so that the diaphragm *B* moves with the inner drum while the diaphragm *A* remains fixed to the center shaft *C*. T he squeezing action now begins.

The cloths are then carried upward on *B* until they come in contact with *A* and are squeezed. The drum then reverses automatically and the cloths are rubbed.

The machine is supplied complete with all gear wheels, pulleys, automatic reversing gear, water and steam inlets and outlets, etc. The outer case is made of galvanized steel plate and the inner drum of brass and fitted with the patent movable diaphragms.

Taking an ordinary example, the standard size of machine will deal at each operation with about fifty to sixty cloths each measuring about 27 x 54 in. (that is to say, cloths that would be used on a press with plates 25 in. square). In the majority of cases only hot water and steam will be necessary, when the washing time would be about fifteen to twenty minutes, but with oils, varnishes and similar materials the time would be somewhat longer, depending upon the nature of the filtrate, and for these it is necessary to use special solvents.

Although this machine is primarily intended for washing filtercloths, it is being used with entirely satisfactory results for washing overalls, sponge cloths, cotton wipers, bags, etc.

New Types of Industrial Cars

The many new processes developed since American industries were thrown on their own resources in the matter of chemicals have necessitated much new and special equipment.

The illustration, Fig. 1, shows a new type of side dump car, built for the Contact Process Company by the Orenstein-Arthur Koppel Company of Koppel, Pa.

The material to be transported comes from the furnaces in a liquid form at a comparatively high temperature and solidifies on cooling. These cars were specially designed in order to provide an efficient means for handling and transporting this material, which flows directly from the furnaces into the cars.

FIG. 1—SIDE DUMP CAR WITH COVER

When the body is filled the cover is applied and the car allowed to stand until the material has solidified. The cover is then removed, the car body is tilted over and the solid cone slides out of the body in convenient form for further transportation.

The accompanying illustration, Fig. 2, shows a striking difference between standard American practice and that of South America in the design of dump cars.

The car shown here is of the square-box, side-dump type, built by the above company for use in the South American nitrate industry.

The cars are of exceptionally heavy steel construction in order to stand up under the severe operating conditions which prevail in the nitrate field.

They are supported on cast steel cradles, designed so that they require a minimum amount of effort to dump and right them. When the car is dumped it tilts to a considerable angle before the door latches are knocked off, thus insuring a clean discharge and causing the load to be thrown clear of the rails.

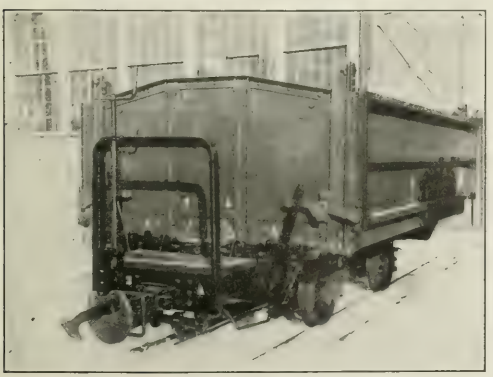


FIG. 2—SQUARE BOX SIDE DUMP CAR

Personal

Mr. **Charles J. Barr,** formerly general superintendent of the Ensley steel plant of the Tennessee company, will be the new general manager of the Fairfield works of the same company.

Dr. **Charles Baskerville,** professor of chemistry in the College of the City of New York, has been appointed by the Ramsay Memorial Committee to organize a committee in the United States for receiving subscriptions to the fund from Americans.

Mr. **W. H. Coghill** of the Bureau of Mines will assist Thomas Varley, superintendent of the Seattle station, in the investigation of ore dressing, which is to be one of the principal lines of work at the Seattle station. Mr. Coghill will continue his work on the molecular physics of flotation as applied to Oregon ores.

Dr. **J. Ehrlich** has been appointed chief chemist of the Verona Chemical Company, North Newark, N. J.

Mr. **A. W. Hudson** of the Phelps Dodge Corporation, Research Staff, has moved to Burro Mountain Copper Company branch to conduct some large scale experiments for the company.

Mr. **J. C. Mooar** has been appointed acting manager of the Atlanta sales office of the Pratt Engineering & Machine Company, owing to the absence of the manager of the office, Mr. J. B. Jacoway.

Mr. **Fred W. Padgett,** who for the past four years has been research fellow in oil, gas and gasoline in the University of Pittsburgh, has been appointed associate professor of chemistry in the University of Oklahoma, where he will have charge of developing a research department in oil, gas and gasoline.

Mr. **E. Gybbon Spilsbury** sailed from New York on July 26 for Central America and expects to be absent until the end of August.

Prof. **Ernest E. Thum** has joined the staff of METALLURGICAL AND CHEMICAL ENGINEERING as associate editor. He is a graduate of the Colorado School of Mines. His first professional experience was as draftsman with the Minnequa Plant of the Colorado Fuel and Iron Company, during the construction of the East mills. From 1906 to 1914 he was employed by the Anaconda Copper Mining Company, first at the Washoe plant as constructing engineer on hydroelectric and water supply development, then as draftsman on the stack and flue system at the Great Falls plant. He then acted as chief civil engineer in the construction of the Tooele plant of the International Smelting & Refining Company, and upon the completion of this work was transferred back to the Great Falls plant, where he was engineer in charge of construction during the reconstruction of the smelter departments of that works. On cessation of operations due to the outbreak of the European war, Mr. Thum became assistant professor of metallurgy at the University of Cincinnati, taking charge of the department of metallurgical engineering in Dean Schneider's Co-operative Engineering College. During his teaching experience, Mr. Thum published "A Practice Book in Elementary Metallurgy" as well as a number of articles in the technical press.

Mr. **John T. Wilkin** has been elected president of the Connersville Blower Company, Connersville, Ind., in addition to his duties as engineer. Mr. Wilkin was one of the organizers of the company in 1892.

CURRENT MARKET REPORTS

The Iron and Steel Market

The stagnation in the iron and steel markets has continued. Practically nothing has been done in scrap, dealers being afraid to buy or sell or even to match sales and purchases. Business in pig iron has been confined to a relatively few small lots for early shipment. There has been no tonnage of the least importance in unfinished steel. Transactions in finished steel have been in small lots for relatively early shipment, together with a very moderate volume of contract business, placed on mill books at inside prices to take care of regular customers.

There has been no demand and likewise there have been no offerings. The producers know they could not sell by trying to force the market. It is a waiting game, and while nothing seems to transpire the fundamental conditions are rapidly lining up for a complete rehabilitation in the market. This is absolutely necessary in order that business may go on. The entire steel output of the country could not possibly be absorbed at the prices lately quoted as the market. Those prices have been fictitious in the sense that they are not applicable to the great bulk of the production. They have been obtained only on relatively small sales to buyers peculiarly situated. Some few make finished wares of such character that the cost of the steel in them, however great, is a mere bagatelle. Other buyers have been fairly well covered at much lower prices, and bought small tonnages at fancy prices to eke out, the average cost of the total being moderate.

A few weeks ago the iron and steel trade was in the throes of discussion whether there would be regulation of prices by the Government. Some authorities did not seem to realize that the Administration had been given no authority to regulate prices, except as to its own purchases. Nearly all expressed the conviction that Government regulation would be very awkward if not impossible. When the iron and steel price control feature was dropped from the Food Control bill in the Senate (the bill as finally approved provides for strict control of coke prices only) the trade began to realize that possibly the market would adjust itself. Scrap prices had started to decline, pig iron had softened, and finished steel prices had ceased to advance, before President Wilson made his appeal for the foregoing of "unusual profits" and for "one price to all." That statement was published July 12. Since then the trade has marveled more and more at the complete stagnation that followed it, and has come to admit that the natural laws of business decree that iron and steel prices must come down to a reasonable level before trading can be resumed.

The President's finesse did not stop with the "appeal" of July 12. An embargo has been placed on the exportation of certain iron and steel products without licenses and it has been intimated that the granting of licenses is to be greatly restricted, while additional commodities may be included in the embargo list. The Government purchases of steel have been made chiefly on the basis of prices to be fixed later. Purchases on behalf of the Entente Allies have been almost entirely held in abeyance. To the keen observer of iron and steel market habits all this appeals as finesse of the highest order. President Wilson has no power to dictate prices for the iron and steel market at large and undoubtedly would prefer that there should be no occasion for such authority to be given or exercised. Time will provide the readjustment through the operation of natural laws.

Reference has been made to the so-called "law of supply and demand." For nearly two years it was a case of demand rather than of requirements. Demand is what the buyer calls for, not what he requires. For nearly two years demand was based upon the buyer's fears, that if he did not buy far ahead he would secure no material when the time came. Now, when that period of fear is fully ended the jobbers and manufacturing consumers generally are found to be fairly well stocked with material. Some jobbers are going far afield to dispose of surplus stocks. Manufacturing consumers have reduced their specifications against current contracts. As to actual requirements in the future it is obvious that there are to be great reductions in many quarters, for instance, practically no new building projects are being undertaken and the railroads are out of the market.

The war requirements in steel are proving to be rather lighter than expected. It is impossible to make close estimates, but some measure of the possibilities may be obtained by considering that last year the production of rolled steel in the United States was 30,500,000 tons while the production in England was 7,500,000 tons. The British production was absorbed very largely in the prosecution of the war, apart from such portion of the 2,400,000 tons exported as did not go to England's allies for war purposes. If the United States should use as much as England, or twice as much, the remainder, for the arts of peace, would be extremely large, and a relatively small decrease in such consumption would release the steel needed for the war. It is to be noted furthermore that while the production of steel ingots in the United States in 1916 was about 41,500,000 tons, the present capacity is about 49,500,000 tons, while nearly 4,000,000 tons is under construction.

The general price readjustment has already started, and quite in accordance with the precedents established in previous declines. Scrap began to decline late in June and pig iron softened somewhat, early in July. In the past few days there have been offerings of unfinished steel at prices much below those formerly ruling, there being offerings of billets at $85, or $10 below the previous market, and of sheet bars at $90, or $15 below the previous market. Declines in finished steel are still to come, quite according to the usual order.

Non-Ferrous Metal Market

Wednesday, Aug. 8.—Prices in most of the metals have remained practically stationary. Copper, tin, lead and spelter are all unchanged.

Copper.—The hot weather affected both the production and consumption of copper. Electrolytic is quoted at 27.50 to 28.25 cents for prompt delivery; 26 to 27 cents, third quarter and 24.50 to 25 cents fourth quarter. Lake remains unchanged at 29.50 cents. The Boston News Bureau estimates the copper refinery production for July as 180,000,000 lb. with the total for the first seven months of the year 1,235,000,000 lb.

Tin.—Straits tin is unchanged at 63.50 to 64.00 cents, with no new developments. Chinese No. 1, 99 per cent is offered at 55 to 56 cents. Banca tin is held at 60.00 to 60.50 cents.

Lead.—The trust price remains at 11.00 cents spot, New York. Independents are, however, offering lead at 10.75. The Government is understood to have purchased 8000 tons more at 8.00 cents St. Louis.

Spelter.—The Government has asked for open bids on 11,500,000 lb. of grade "C" spelter, thereby deviating from its method of purchasing grades "A" and "B" which it decided to purchase at cost plus a fair profit. It will be interesting to watch the outcome of this bidding. Prompt spelter is quoted at 8.75 New York.

OTHER METALS

Antimony, Chinese and Japanese lb.	$0.15
Aluminum, No. 1 Virgin, 98-99 per cent, lb.	.49
Magnesium, metallic, lb.	2.00-2.50
Nickel, electrolytic, lb.	.55
Cobalt, lb.	2.70
Cadmium, lb.	1.50
Quicksilver, flask	115.00
Silver, oz.	.80¾
Platinum, pure, oz.	105.00
Palladium, oz.	115.00
Tungsten, powder, 95 per cent, lb.	2.80

Chemical Market

COAL TAR PRODUCTS.—While a majority of items under this classification remain in a position that generally favors the buyer, there has been nevertheless considerable activity noted during the past fortnight. The general opinion is that the market will react in favor of the seller with the advent of early fall.

Benzol.—This market has probably represented the weakest spot in the coal tar situation during the two weeks under review. Holders have expressed considerable disappointment with the situation but hope that a demand will shortly develop that will take care of the heavier offerings that have been noted of late.

Aniline Oil.—Values have been a trifle easier in this market but there has been no pronounced drop. There has been a fair domestic demand which has in a way taken care of the accumulated offerings. The export movement has been rather slow.

Paranitraniline.—The movement in this product has been slow and prices are not firm. Production is quite large. *Metanitraniline* in contrast is particularly scarce with practically no production. Preparation is being made however for new outputs.

Toluol.—While there has been some resale material on the market the position is firm and practically all producers are sold out for a lengthy period.

T. N. T.—The government has been buying all trinitrotoluol available and all plants equipped to produce the product have been working to capacity.

Paratoluidine.—There has been a strong and active inquiry noted for this intermediate. The *ortho*, however has moved somewhat slower. *Paranitrotoluol* is another product that has been in active request.

Xylol.—A sluggish market has been noted and pure has been sold at lower prices. Production is considerably in excess of demand.

Solvent naphthas.—While there has been a fairly good demand noted for this solvent there is a big production noted and prices are a shade easier.

Cresylic Acid.—A fair demand is noted for disinfectant purposes and there is also a movement noted to South America. The high duty prohibits imports from England except on order.

Naphthalene.—While there have been several large contracts placed during the interval the demand has not been general. Prices are about the same.

Alpha Naphthylamine.—Quietness prevails, and with the new producers offering prices are lower.

Phenol.—There has been very important business noted during the interval, one manufacturer selling 750,000 lb. in one day. Prices, however, have been shaded to meet buyers' views. The situation looks stronger.

Dinitrophenol.—The production is increasing noticeably and price shading has resulted in an effort to move stocks.

HEAVY CHEMICALS.—Summer dullness has prevailed, but there has been some special activity noted.

Caustic Soda.—An extremely firm tone has prevailed in this market. Manufacturers have sold up and business appears to be in the hands of resellers. Contracts have been in urgent request and there has been a big demand for 1918. All positions on caustic are higher. *Soda Ash*—While the spot market is unchanged futures are higher, and there has been an active and urgent request for 1918 contracts. Speculative buying has been quite pronounced. *Acetate of soda* is pretty well under contract, but there have been no changes of consequence noted. *Bicarbonate of soda* has been in fair demand with prices higher, and some are sold up. *Silicate of soda* has been very strong, as the few producers are sold up. *Sulphide of soda* has been in very active demand for both domestic and export account, and the production is not keeping pace with the demand. *Bichromates* have been in fair demand, with supplies moderate and the market steady. *Bleaching powder* has been very weak, as is usual in the midsummer. Futures, however, are in better request.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, AUG. 8, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.33 —	.35
Acid, acetic, 28 per cent.	lb.	.05¼—	.05½
Acetic, 56 per cent.	lb.	.11 —	.11½
Acetic, glacial, 99½ per cent, carboys.	lb.	.36 —	.38
Boric, crystals	lb.	13 —	.13½
Citric, crystals	lb.	.72½—	.73
Hydrochloric, commercial, 18 deg.	lb.	.01¾—	.01⅞
Hydrochloric, 20 deg.	lb.	.02 —	.02¼
Hydrochloric, C. P., conc., 22 deg.	lb.	.02¼—	.02½
Hydrofluoric, 30 per cent, in barrels	lb.	.04¾—	.05
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.04½—	.05
Nitric, 36 deg.	lb.	.06½—	.06¾
Nitric, 42 deg.	lb.	.08 —	.08¼
Oxalic, crystals	lb.	.46 —	.47
Phosphoric, 85 per cent.	lb.	.33 —	.37
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3 50 —	4.00
Sulphuric, 60 deg.	ton	24 00 —	26 00
Sulphuric, 66 deg.	ton	34 00 —	36.00
Sulphuric, oleum (Fuming), tank cars	ton	45 00 —	50.00
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.75 —	.79
Tungstic, basis 100 per cent.	lb.	1.80 —	...
Alcohol, grain, 188 proof	gal.	4 10 —	4.15
Alcohol, wood, 95 per cent	gal.	1.00 —	1.02
Alcohol, denatured, 180 proof	gal.	1 00 —	1.02
Alum, ammonia lump	lb.	.04½—	.05
Alum, chrome ammonium	lb.	.18 —	.20
Alum, chrome potassium	lb.	.35 —	.36
Alum, chrome sodium	lb.	.14 —	.15
Alum, potash lump	lb.	.07½—	.08
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03½—	.03¾
Ammonia aqua, 26 deg. carboys	lb.	.12 —	.13
Ammonium carbonate	lb.	.13 —	.14
Ammonium nitrate	lb.	.16 —	.17
Ammonium, sulphate domestic	100 lb.	6.80 —	6.90
Amyl acetate	gal.	4 50 —	4 60
Arsenic, white	lb.	.17 —	.18
Arsenic, red	lb.	.60 —	.65
Barium chloride	ton	85 00 —	90 00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.11 —	.11½
Barium peroxide, 80 per cent.	lb.	.28 —	.30
Bleaching powder, 35 per cent chlorine	lb.	.01¼—	.01¾
Borax, crystals, sacks	lb.	.07¾—	.08
Brimstone, crude	ton	55.00 —	60 00
Bromine, technical	lb.	.80 —	.90
Calcium acetate, crude	per 100 lb.	5.25 —	5.30
Calcium carbide	ton	80.00 —	90 00
Calcium chloride, 70-75 per cent, fused, lump	ton	30.00 —	31 00
Calcium peroxide	lb.	1.60 —	1.65
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	.10 —	.12

Carbon bisulphide	lb.	.06½	—	07
Carbon tetrachloride, drums	lb.	.16½	—	16¾
Caustic potash, 88-92 per cent	lb.	.85	—	87
Caustic soda, 76 per cent	lb.	.07½	—	07⅝
Chlorine, liquid	lb.	.15	—	40
Cobalt oxide	lb.	1.60	—	1 65
Copperas	100 lb.	1.00	—	1 05
Copper carbonate	lb.	.32½	—	35
Copper cyanide	lb.	.72	—	74
Copper sulphate, 99 per cent, large crystals	lb.	.09¾	—	09¼
Cream of tartar, crystals	lb.	.48½	—	50
Epsom salt, bags	100 lb.	3.85	—	4 00
Formaldehyde, 40 per cent	lb.	.17	—	18
Glauber's salt	100 lb.	.72	—	80
Glycerine, bulk, C. P.	lb.	.63½	—	64
Iodine, resublimed	lb.	4.25	—	
Iron oxide	lb.	.02	—	08
Lead, acetate, white crystals	lb.	.16	—	17
Lead arsenate	lb.	.12¾	—	13½
Lead nitrate	lb.	.17½	—	18
Litharge, American	lb.	.08	—	19
Lithium carbonate	lb.	1.02	—	1 05
Manganese dioxide, U. S. P.	lb.	48	—	55
Magnesium carbonate, tech	lb.	.13½	—	14
Nickel salt, single	lb.	.11	—	11½
Nickel salt, double	lb.	.08	—	08½
Phosphorus, red	lb.	1.25	—	1 30
Phosphorus, yellow	lb.	2.40	—	2.45
Potassium bichromate	lb.	.37	—	37½
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.75	—	78
Potassium chlorate, crystals	lb.	.50	—	55
Potassium cyanide, 98-99 per cent	lb.	2.30	—	2.50
Potassium iodide	lb.	2.90	—	2.92
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	340.00	—	350.00
Potassium nitrate	lb.	.31	—	33
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.75	—	2 80
Potassium prussiate, yellow	lb.	1.08	—	1 12
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	325.00	—	350 00
Rochelle salts	lb.	.39	—	39½
Sal ammoniac, gray gran	lb.	.10	—	11
Sal ammoniac, white gran	lb.	.15	—	16
Sal soda	100 lb.	1.20	—	1 25
Salt cake	100 lb.	.95	—	1 05
Silver cyanide	oz.		—	
Silver nitrate	oz.	.49⅞	—	50⅛
Soda ash, 58 per cent, light, flat	100 lb.	2.85	—	3 00
Soda ash, 58 per cent, dense, flat	100 lb.	3.75	—	4 00
Sodium acetate	lb.	.09½	—	10
Sodium benzoate	lb.	3.75	—	4.00
Sodium bicarbonate, domestic	100 lb.	2.35	—	2 50
Sodium bicarbonate, English	lb.		—	
Sodium bichromate	lb.	.15⅞	—	16½
Sodium bisulphite, powd	lb.	.04	—	04½
Sodium chlorate	lb.	.23	—	25
Sodium cyanide	lb.	.47	—	50
Sodium fluoride, commercial	lb.	.18	—	18½
Sodium hyposulphite	lb.	.01¾	—	02
Sodium nitrate, 95%	100 lb.	4.27½	—	4.30
Sodium nitrite	lb.	.45	—	50
Sodium peroxide	lb.	.85	—	90
Sodium phosphate (tri.)	lb.	.05	—	05¼
Sodium prussiate, yellow	lb.	.32	—	33
Sodium silicate, liquid—40 deg. Baumé	100 lb	2.50	—	2 60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3 10
Sodium sulphide, 60 per cent, fused	100 lb.	4.50	—	4 55
Sodium sulphite	lb.	.03¼	—	03½
Strontium nitrate	lb.	.28	—	30
Sulphur chloride, drums	lb.	.06	—	06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	40
Sulphur, flowers, sublimed	100 lb.	3.20	—	3 30
Sulphur, roll	100 lb.	2.55	—	2 60
Sulphur, crude	ton	45.00	—	50 00
Tin bichloride, 50 deg.	lb.	.19¾	—	20
Tin oxide	lb.	.64½	—	65
Zinc carbonate	lb.	.25	—	27
Zinc chloride	lb.	.10¼	—	11
Zinc cyanide	lb.	.50	—	
Zinc dust, 350 mesh	lb.	.17	—	19
Zinc oxide, American process XX	lb.	.14¾	—	15
Zinc sulphate	lb.	.05½	—	06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.51	—	55
Benzol, 90 per cent	gal.	.50	—	52
Toluol, pure, water white	gal.	1.70	—	1 90
Xylol, pure, water white	gal.	.45	—	50
Solvent naphtha, water white	gal.	.18	—	22
Solvent naphtha, crude, heavy	gal.	.13	—	16
Creosote oil, 25 per cent	gal.	.31	—	33
Din oil, 20 per cent	gal.	.29	—	30
Pitch, various grades	ton	8.00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	.55	—	60
Carbolic acid, crude, 25 per cent	lb.	.32	—	35
Cresol, U. S. P.	lb.	.25	—	

Intermediates, Etc.

Alpha naphthylamin	lb.	.75	—	85
Aniline oil	lb.	.28	—	29
Aniline salts	lb.	.33	—	34
Anthracene, 80 per cent	lb.	.10	—	
Benzaldehyde	lb.	4 00	—	4 50
Benzidine, base	lb.	1 85	—	2 00
Benzidine, sulphate	lb.	1.55	—	1 60
Benzoic acid	lb.	3.75	—	4 00
Benzyl chloride	lb.	1 75	—	2 00
Beta naphthol benzoate	lb	8.50	—	9 00
Beta naphthol, sublimed	lb.	.80	—	85
Beta naphthylamin com	lb.	2 50	—	
Dichlor benzol	lb.	.11	—	20
Dinitrochlorbenzol	lb.	.44	—	46
Dimethylaniline	lb.	.58	—	60
Diphenylamine	lb.	1 00	—	1 05
H-acid	lb.	3.25	—	3 50
Metaphenylenediamine	lb.	1 75	—	1 80
Monochlorbenzol	lb.	.22	—	24
Naphthalene, flake	lb.	09	—	09¼
Naphthionic acid, crude	lb.	1 50	—	1 75
Nitro naphthaline	lb.	.45	—	50
Nitro toluol	lb.	.50	—	55
Ortho-amidophenol	lb.		—	
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.75	—	5.50
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	1.90	—	2.10
Phenol, U. S. P.	lb.	.40	—	.42
Resorcin, technical	lb.	8 00	—	9 00
Resorcin, pure	lb.	15.00	—	16 00
Salicylic acid	lb.	1.50	—	1 75
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.33
Toluidin	lb.	3.00	—	
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.10	—	
Corning, Ohio	bbl.	2.40	—	
Somerset, Ky	bbl.	2.20	—	
Wooster, Ohio	bbl.	2.18	—	
Indiana	bbl.	1.78	—	
Illinois	bbl.	1.92	—	
Oklahoma and Kansas	bbl	1 85	—	
Caddo, La., light	bbl.	1.90	—	
Corsicana, Tex., light	bbl.	1.70	—	
California	bbl.	.98	—	1 29
Gulf Coast	bbl.	1.00	—	

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, 903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	

Vegetable and Other Oils

China wood oil	lb.	.17	—	19
Cottonseed oil, crude	gal.	.96	—	.97
Linseed oil, raw, cars	gal.	1.17	—	
Peanut oil, crude	gal.	1 15	—	
Rosin oil, first run	gal.	.35	—	
Rosin oil, fourth run	gal.	.66	—	
Soya bean oil, Manchuria	lb.	.12¾	—	13¼
Turpentine, spirits	gal.	.42	—	

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	28.00	—	32.00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, flor	lb.	.53	—	
Casein	lb.	.19	—	.28
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	
Rosin, 280 lb.	bbl.	6.00	—	
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	.11½	—	

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	45.00	—	50.00
Clay brick, second quality	per 1000	30.00	—	
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	90.00	—	
Magnesia brick, Grecian, 9x4½x2½	net ton	140.00	—	
Silica brick	per 1000	50.00	—	

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	
Ferrochromium	lb.	.20	—	
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375 00	—	
Ferromolybdenum, per lb. of Mo	lb.	4 00	—	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200.00	—	225.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.95	—	
Ferrouranium, f.o.b. works, per lb. of U	lb	7.00	—	
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Molybdenite, per lb. of MoS_2	lb.	2.10	
Tungsten, Scheelite, per unit of WO_3	ton	26 00	
Tungsten, Wolframite, per unit of WO_3	ton	25.00	
Uranium oxide, 96%	lb.	3.50	
Vanadium Pentoxide, 99%	lb.	11 00	

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The All-Steel Wheel Company, Philadelphia, Pa., has filed articles of incorporation under Delaware laws with a capital of $200,000 to manufacture steel wheels. F. R. Hansell, Philadelphia; J. V. Pimm, and S. C. Seymour, Camden, N. J., are the incorporators.

The American Alcolene Corp., Dover, Del., $20,000,000. To deal in all liquids of all kinds, including petroleum.

The American Iron & Furnace Company, Clinton, Iowa, has been incorporated in Delaware with capital of $150,000 to operate an iron furnace and smelting plant. J. E. Moran, F. A. Hohenschuh, T. S. Peterson, Jr., and C. J. Metzger, all of Clinton, are the incorporators.

The American Marbelite Company, Dover, Del., has been incorporated with a capital of $5,000,000 to manufacture composition specialties of vitrous materials. H. L. Mullin, C. L. Rimlinger and Clement M. Egner, Wilmington, are the incorporators.

The American Mine & Torpedo Company, East Orange, N. J., has been incorporated with a capital of $100,000 to manufacture mines and munitions. Gordon Grand, L. Matthews and H. H. Picking, all of East Orange, are the incorporators.

The American Petroleum Co., Baltimore, Md., $1,500,000. To deal in petroleum and its products. The incorporators are Matthew Gault, Harold Tschudi and William D. MacMillan.

The Belleville Metal & Chemical Co., Belleville, N. J., has been incorporated with a capital of $50,000 to manufacture chemicals. Charles and Jacob Bobker and David Silver are the incorporators.

The Berkshire Rubber Company of New York, Inc., Albany, N. Y., has been incorporated with a capital of $10,000 to manufacture rubber goods. T. D. McMurray and A. and B. Wurts, all of Albany, are the incorporators.

The Black Diamond Oil Company, a $25,000,000 corporation, which was recently organized by prominent Western and Eastern capitalists, has been quietly financing and accumulating valuable oil proven and producing acreage in Kentucky, Mississippi, Michigan, Wyoming, Oklahoma, Indiana and the Coastal Oil Belt of Texas. The following companies will be merged under the Black Diamond banner, either by direct purchase or control of stock: The Alcoken Oil Company, Rising Sun Oil Company, Thayer Oil & Gas Company, Wyoming Producing & Refining Company and the Monticello Oil & Gas Company. The holdings of this merger are approximately 800,000 acres, over half of which is owned in fee. Some of the men associated in the deal are C. C. Marshall, Drumright, Okla.; B. M. Robinson, Joplin, Mo.; J. W. Mettler, Chicago; Marion W. Edwards, Casper, Wyo.; E. C. Lott, Chicago; J. D. Cameron, New York; R. H. Owen, Chicago; James A. Wallace, Irvine, Ky.; F. M. Smith, St. Louis; Morris M. Becher, New York; F. W. Church, Jefferson City, Mo.; W. A. Otto, Chicago; L. C. Moch, Casper, Wyo.; Hon. J. M. Hayes, Oklahoma City; Edward Hilp, Louisville; O. A. Kintz and A. C. McClaughry, Chicago.

Briggs & Co., Inc., Providence, R. I.; $5,000. To do a chemical manufacturing business. Incorporators: Annie M. Briggs, Frances A. Rieckel and Willard M. Dean.

The Brooklyn Standard Laboratory, Brooklyn, N. Y., has been incorporated with a capital of $10,000 to manufacture chemicals. P. F. Lahm, P. W. Schumacher and L. Schopfer, 213 Cornelia Street, Brooklyn, are the incorporators.

The Carr Leather Company, Dover, Del., $120,000. To manufacture leather.

The Columbia Fuller's Earth Company, Kettle Falls, Wash., has been incorporated for $20,000, with headquarters in this city. Incorporators are Henry Severin, Herman N. Zapel, Edward Severin and Raymond Zapel, and company will develop a large deposit of Fullers earth near Kettle Falls.

Conewago Chemical Co., Warren, Pa., $75,000. W. G. Heasley, incorporator.

Cosden & Co., Wilmington, Del., $32,000,000. To produce and prepare for market petroleum and natural gas in all forms.

The Diarsenol Company, Inc., Buffalo, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals. G. A. Webster, A. E. Jones and J. J. Henry, Buffalo, are the incorporators.

Dixie Foundry Co., Cleveland, Ohio, $40,000. To engage in the general foundry business. Incorporators: S. B. Rymer, J. P. O'Neill, J. S. O'Neal, P. B. Mayfield, Chas. S. Mayfield.

Durst Products Company of America, Delaware; $250,000. To deal in oil and natural gas. Incorporators are C. L. Rimlinger, H. C. Mullin, Clement M. Egner, Elkton, Md.

Franklin Founders Corporation, Delaware: $2,000,000. To conduct a general foundry business. Incorporators: F. D. Buck, M. L. Horty, K. E. Longfield, Wilmington, Del.

General Refining Co., Delaware; $750,000. To acquire oil lands and market products of same. Incorporators are Arthur W. Britton, Samuel B. Howard, Louis H. Gunther, New York City.

The Helkulin Chemical Co., 929 Madison Street, Hoboken, N. J.; $7,000. To deal in all kinds of dyestuffs. Incorporators are R. Helwug, C. W. Kuhle, M. Lingren.

High Gravity Oil Co., Delaware, $3,000,000. To drill and market oils. Incorporators: H. I. Mullin, Clement M. Egner.

Indiana Window Glass Co., Vincennes, Ind.; $100,000. To manufacture, buy and sell window glass. Incorporators: F. Bastian, J. A. Sweet, L. A. Meyer and Anton Simon.

Industrial Electric Furnace Co., Indianapolis, Ind.; $500,000. Incorporators: Chas. B. Sommers, Chas. B. Fletcher, F. von Schiegell, F. T. Snyder and S. A. Fletcher. The company will operate its factory in Indianapolis for the manufacture of electric furnaces. The main offices will be in Chicago.

International Sisal & Petroleum Co., New York; capital, $1,000,000. To acquire lands suitable for growing agave, hemp, flax, etc.

The Iron & Ore Corporation of America, New York, has been incorporated with a capital of $250,000 to engage in the production of iron, steel and other metals. V. E. Seipgens, R. R. Ely and J. M. Lowenstein, 11 West Ninetieth Street, are the incorporators.

The Legeim Rubber Company, Jersey City, N. J., has filed articles of incorporation with a capital of $25,000 to manufacture rubber goods of various kinds. F. Losche, A. McMahon and C. B. Hermans, Jersey City, are the incorporators.

The McKeesport Enameling Company, McKeesport, Pa., has been incorporated in Delaware with a capital of $50,000 to manufacture paints and varnishes. A. Clifford Wiltshire, J. R. Woreley and James W. Nesbitt, McKeesport, are the incorporators.

The Machine Composition Company, Philadelphia, Pa., has filed articles of incorporation with a capital of $18,000 to manufacture printing type. B. F. Banes is the principal incorporator.

Merry Oil & Refining Co., Delaware; $1,000,000. To acquire oil lands and develop the same. Incorporators are E. L. Merry, R. A. Moody and L. Harden.

Mitchell Chemical Co., Altoona, Pa., $5,000. W. R. Merrill, incorporator.

Monitor Oil & Refining Co., Delaware; $1,000,000. To acquire and develop oil lands of all kinds. The incorporators are Walter P. Carrow, George T. Maxwell, Local Dover.

The National Synthetic Rubber & Tire Company, New York, has been incorporated in Delaware with a capital of $1,000,000 to manufacture tires and other rubber goods. Arthur W. Britton, S. B. Howard and John A. Moore, New York, are the incorporators.

The National Tractor Company, Georgetown, Del., has filed articles of incorporation with a capital of $2,500,000 to manufacture tractors and parts. C. W. Cullen, Albert Worth and W. Martin, all of Georgetown, are the incorporators.

The Nichols-Vogt Chemical Company, Buffalo, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals. Charles J. and Dayton G. Vogt, and Walter C. Nichols, all of Buffalo, are the incorporators.

The Nitrogen Fixation Corporation, New York, has filed articles of incorporation with a capital of $1,000,000 to manufacture chemicals and allied products. The incorporators are J. R. Rubin, J. F. A. Comstedt and S. M. Well, 34 Pine Street.

The Penn York Gas & Oil Co., Batavia, N. Y.; $1,000,000.

Pittsburgh-Illinois Oil & Gas Co., Pittsburgh, Pa.; $100,000. W. A. McCoy, Geo. W. Morgan, W. I. N. Lofland.

The Pittsburgh Mining Machine Company, Pittsburgh, Pa., has filed articles of incorporation with capital of $100,000 to manufacture mining machinery. T. H. Edelblute heads the company.

The Procaline Company, Inc., New York, has filed articles of incorporation with a capital of $10,000 to manufacture chemicals. J. E. Vidal, R. G. Contrell and F. L. McIlvaine, 257 West 136th Street, are the incorporators.

The Progressive Machine & Metal Products Company, New York, has been incorporated with a capital of $10,000 to manufacture boilers, machinery, etc. A. Kipness and L. Olitsky, 1517 Fifty-third Street, are the incorporators.

Protection Paint Co., Inc., Brooklyn, N. Y.; $10,000. General manufacturing and sale of paint, varnishes, chemicals. Incorporators are J. Karjian, M. Bartholomew, P. Lamperpoulos, 66 Fifth Avenue, Brooklyn.

The Pyrohodol & Chemical Co., Inc., Chicago, Ill.; $15,000. Incorporators are Samuel M. Come, H. Weintraub, Alfred Weissenbach.

Santa Rita Fuel & Iron Co., St. Louis, Mo.; $500,000.

The Seneca Electric Furnace Corporation of Albany, N. Y., has been incorporated for the purpose of manufacturing and selling electric furnaces for steel making and other purposes. Thornton W. Price is vice-president and general manager and Edwin Corning is treasurer. The New York office of the company is located in the Woolworth Building.

Smelter Steel Co., Seattle, Wash.; $1,500,000. Corwin S. Shank, incorporator.

Sussex Iron & Steel Co., New York; $1,000,000. To manufacture and sell and deal in and with steel, copper, nickel, etc.

Tennessee Manganese Co., Wilmington, Del.; $300,000. To manufacture iron, steel, etc.

The Thermit Welding & Modern Torch Company, Seattle, has been incorporated for $4,000 by T. A. Errett, R. A. Redman, et al, Concern will establish a welding plant in Seattle.

The United Steel & Metal Corporation, New York, has been incorporated with a capital of $100,000 to engage in the manufacture of iron, steel and other metal products. A. Heller, F. Viethardt and M. Sternberg, 906 Broadway, are the incorporators.

Washburn Wire Company, Madison, N. J.; $11,000,000. To manufacture iron, steel, copper and other metals.

The Watts Tool & Machine Company, Turtle Creek, near East Pittsburgh, Pa., has been incorporated with a capital of $100,000 to operate a local works. C. J. Watts, Turtle Creek, is the principal incorporator.

The Wearwell Gasket & Packing Company, Camden, N. J., has been incorporated with a capital of $25,000 to manufacture rubber packing and kindred specialties. Joseph A. Whitney, Eleventh and Linden Streets; John K. Stevenson and James V. Waring, Camden, are the incorporators.

Capital Increases

The Haloid Company, Rochester, N. Y., has increased its capital from $75,000 to $150,000. The company specializes in the production of photographic papers.

The Western Utah Extension Copper Company, Pittsburgh, Pa., has increased its capital from $1,500,000 to $2,500,000 for expansion.

The Champion Paper Company, Watertown, N. Y., has increased its capital from $100,000 to $500,000.

The More-Jonas Glass Company, Bridgeton, N. J., has increased its capital from $100,000 to $250,000 for expansion. The company specializes in the manufacture of bottles and jars.

Construction and Operation

California

MARTINEZ.—Preparations are being made by the Shell Oil Company to begin the $1,000,000 worth of new work on its plant here, including construction of 55,000 barrel steel tanks, for which a contract has been let.

OAKLAND.—The new open-hearth furnaces at the Judson works were started early in July. W. D. Bunker has been made general manager of the entire Judson Company, with charge of both the Emeryville and the San Francisco plants. Mr. Bunker has already begun the work of reconstruction. General plans have been made that will involve an ultimate expenditure of a quarter of a million dollars. The next move that will be made in this reconstruction plan will be the wrecking of the old rolling mill and the construction of a modern steel structure with hollow tile walls. This will cost about $40,000. When this is finished, a complete equipment of traveling cranes will be installed. This will be followed by other reconstruction until the old plant has been entirely demolished and an entirely new Judson works has arisen at Emeryville.

RED BLUFF.—Tehama County is fast forging to the front as one of the greatest chrome producers in the State. For 15 or 20 miles along the coast range of mountains in Tehama County chrome ore crops out at intervals of two or three hundred feet. At the present time this industry is receiving more attention by outside capital than any other metal mined in the north. Already numerous big properties are being developed and at the present time there are three companies shipping ore.

RICHMOND.—E. A. Maas and his associates of Philadelphia and Los Angeles will erect a carbon factory here, which will cost $500,000. Work on the factory will start at once. This is the third carbon plant to locate here, the reason being that much of the material used comes from the Standard Oil refinery.

SAN FRANCISCO.—Byron Jackson Iron Works of San Francisco, Cal., are erecting a new $100,000 machine shop at their plant at West Berkeley. The new shop will be ready for occupancy about Nov. 1.

Idaho

BOISE.—The American Nitrate Company is investigating some sodium and potassium nitrate properties in eastern Oregon, in Lake and Harney counties. A. E. Robinson is superintendent in charge of work. C. R. Cole, Marquette Building, Chicago, is interested.

KELLOGG.—The Bunker Hill & Sullivan smelter was blown in recently, one of the three furnaces being started, a charge consisting of Caledonia ore. The smelter, it is said, is one of the most complete and modern in the world. It cost about $1,000,000. It has been so constructed that it may be enlarged from time to time as the demands make necessary. The first improvement to be constructed will be an electrolytic zinc plant, this having been recently decided upon.

Illinois

FEDERAL.—The Consolidated Chemical Products Company will erect a plant at Federal, just east of Alton, Ill., for the manufacture of salts of zinc and barium.

Indiana

WINCHESTER.—The Woodbury glass factory, which was destroyed by fire at a loss of at least $115,000, will resume operations not later than November 1. This announcement was made following a meeting of the board of directors. The factory will be operated on a much larger scale, and will include more territory.

Kansas

WICHITA.—L. C. Hill, president of the Nith Chemical Company of Lawrence, Kan., was recently here looking for a location for a branch plant. The company manufactures medicinal products.

Louisiana

MONROE.—Edwin E. Binney and other New York capitalists plan the construction of a large carbon plant at Fairbanks City, which will cost $200,000. They have recently purchased an oil and gas lease from the Great Southern Oil Company.

Maryland

BALTIMORE.—The Black & Decker Mfg. Company, 105 South Calvert Street, manufacturer of air compressors, electric drills, etc., has awarded a contract for the construction of a new one-story shop, 60 x 200 ft., at Towson. The Cowan Building Company, 106 Madison Street, Baltimore, is the contractor.

BALTIMORE.—The Maryland Brass & Metal Works has awarded a contract to the Price Concrete Construction Company, Maryland Trust Building, for the construction of the proposed new two-story addition to its plant on Guilford Avenue, 46 x 90 ft., to cost $12,000.

Minnesota

MINNEAPOLIS.—A new chemical plant to manufacture tri-sodium phosphate will be located here in the fall. The new company is incorporated with a capital of $150,000. Other chemicals which will be made include di-sodium phosphate, phosphoric acid and caustic soda.

Nevada

AUSTIN.—The Nevada Austin Mines Company, located at Newpass, twenty-five miles from Austin, will construct a 75-ton cyanide plant for handling of ores. Douglas Muir, metallurgical engineer, has been engaged to draw the plans and superintend the construction of the plant.

New Jersey

CAMDEN.—The Active Chemical Company has removed its works from 1210 Kaign Avenue to a new plant at Ferry and Atlantic Avenues, to provide for increased operations. The company has recently acquired a site of about twenty acres at Mount Ephraim, and expects to commence the erection of a new plant early in 1918. Dr. Edward Kressel, president.

HARRISON.—The Driver-Harris Company of Harrison has filed plans for a foundry in Middlesex Street and Railroad Avenue, to cost $25,000.

HARRISON.—The Crucible Steel Company, South Fourth Street, has awarded contracts to the American Bridge Company for structural steel for additions to its plant, to cost about $75,000.

MAURER.—The American Smelting & Refining Company has awarded a contract for the erection of a new four-story steel pulverizing mill, 55 x 60 ft., to the H. D. Best & Company, 52 Vanderbilt Avenue, New York.

METUCHEN.—The Acme Dyeing & Chemical Company is planning for the erection of an addition to its plant. Charles B. Carman, 406 Main Street, is engineer.

NEWARK.—Fire, July 21, destroyed a portion of the plant of the Cotex Company, 341 Oliver Street, manufacturer of artificial leather, with loss estimated at $10,000.

NEWARK.—Fire, Aug. 2, destroyed the plant of the Roxylite Company, Long Avenue, Hillside district, consisting of about twenty buildings, with loss estimated at $100,000. The plant will be rebuilt. The company specializes in the manufacture of film for motion picture service.

NEWARK.—The Balbach Smelting & Refining Company, Doremus Avenue and Avenue R, will build a new one-story retort furnace at its works.

NEWARK.—The Butterworth-Judson Corporation will build three large one-story extensions to its chemical works on Avenue R, to cost $152,000. Two of the structures will be 140 x 300 ft., and the other, 60 x 445 ft.

NEW BRUNSWICK.—The United States Nickel Company, Allen Avenue, is planning for the construction of an addition to its main plant.

PARLIN.—The E. I. du Pont de Nemours Company has commenced the erection of an addition to its plant for the manufacture of smokeless powder.

ROOSEVELT.—The Tyson Rubber Substitute Company has had plans prepared for the erection of a new plant at Woodbridge.

TRENTON.—The Utah Potash Company, capitalized at $1,500,000, plans the early operation of its new $100,000 plant here. The building is equipped to handle various chemical products.

New York

BALDWINSVILLE.—The Hoffman Paper Company has acquired property on Oswego Street, to be used as an extension to its works.

BROOKLYN.—The Bristol Myers Company, 277 Greene Avenue, manufacturer of chemicals, will build a new one-story plant, 100 x 200 ft., in the Hillside district, near Newark, N. J., to cost about $25,000. Contract for erection has been awarded.

BROOKLYN.—The Chelsea Fibre Mills, 1155 Manhattan Avenue, has awarded a contract for the construction of a two-story brick addition to its plant, 80 x 200 ft., at Manhattan Avenue and Newtown Creek. The Tidewater Building Company, 16 East Thirty-third Street, New York, is the contractor.

BUFFALO.—The Curtiss Aeroplane Company has had plans prepared for a new three-story brick and steel plant to cost about $400,000, to be erected at 1992-2160 Elmwood Avenue.

BUFFALO.—The Wickwire Steel Company is planning for the early operation of its new rod and blooming mill, now nearing completion.

FULTON.—The Arrowhead Mills, Inc., manufacturer of paper, has had plans prepared for a new two-story paper mill, about 80 x 350 ft., to cost $350,000.

NEW YORK.—The General Optical Company, 583 First Avenue, has awarded a contract to A. Barbaresi, 48 South Fourth Avenue, Mt. Vernon, for the erection of a new three-story brick addition, 75 x 275 ft., at First Avenue and Washington Street, Mt. Vernon, N. Y.

NEW YORK.—C. K. Williams & Company, Easton, Pa., have purchased the plant of the Union Carriage & Gear Company for $25,000, and will immediately begin alteration and installation of equipment for the manufacture of rosin size and other paper mill chemicals. Other plants operated by C. K. Williams & Company are located at Kalamazoo, Mich., Holyoke, Mass., Allentown, Pa., Ontario, N. Y., South Carolina and Florida.

SCHENECTADY.—The General Electric Company is planning for the immediate erection of a new one-story foundry, 100 x 110 ft., at its Pittsfield, Mass., works.

SYRACUSE. — The Onondaga Pottery Company, West Fayette Street, is making rapid progress in the erection of new buildings at its plant to form a complete additional unit for manufacturing. Five buildings will be constructed, one four-story, 40 x 130 ft.; two four-story, 40 x 90 ft.; one two-story, 40 x 90 ft.; and one one-story, 40 x 90 ft. It is expected to have the main section of the new extension ready for occupancy in the fall. E. L. Torbert is general manager.

TICONDEROGA.—The Ticonderoga Pulp & Paper Company, North Main Street, will build a one-story, reinforced-concrete addition to its plant, 50 x 150 ft., to cost about $15,000.

Ohio

COLUMBUS.—The Federal Chemical Company has completed its plant in Bonham Avenue, and is ready to occupy the buildings, which cover three acres of the 15 acres in the tract owned by the company. The company will employ 100 persons.

ELYRIA.—The Harshaw-Fuller-Goodwin Company will erect an addition to its plant at a cost of $10,000.

LORAIN.—National Tube Company plans the erection of a benzol plant at this place. Benzol will be made from the 308 by-product coke ovens at the plant.

YOUNGSTOWN.—Extensions of a substantial nature will be made to the plant of the Youngstown Iron & Steel Company, controlled by the Sharon Steel Hoop Company of Sharon, Pa. Plans are rapidly being formulated for these improvements. Two or three open-hearth furnaces will be added, as well as extensions to the finishing departments. Definite plans for these additions will be completed within a very short time. The improvements have been under consideration ever since the Sharon concern acquired the local property. The Sharon Steel Hoop is capitalized at $10,000,000, and it is said to have sufficient capital and other funds available to finance the improvements. They will involve a large outlay and will mean the employment of many more workmen.

YOUNGSTOWN.—Improvements involving the expenditure of $3,000,000 were announced recently by James A. Campbell, president of the Youngstown Sheet & Tube Company. One hundred and two additional by-product coke ovens will be built. The tar products and benzol plant will be increased 50 per cent. The company now has 204 coke ovens, and the additional ones will increase the capacity of this department 50 per cent.

Oklahoma

SAND SPRINGS.—The Mohawk Refining Company will establish another oil refinery, with a capacity of 2000 barrels daily.

Pennsylvania

CHESTER.—The Chester Paper Company will erect a new three-story and basement building, about 155 x 356 ft., at its plant, to be used as a finishing works. The structure will cost about $200,000. The Scott Paper Company, Glenwood Avenue, Philadelphia, operates this company.

LANSDALE.—The Barrows Mfg. Company, manufacturer of rope, cordage and kindred products, has commenced the construction of a new building to be used as a rope manufacturing plant, replacing the structure recently destroyed by fire.

NAZARETH.—The Nazareth Foundry & Machine Company, manufacturer of iron and steel castings and shapes, has been acquired by new interests for a consideration of about $100,000. The new owners are said to be planning to increase the capacity of the works.

PHILADELPHIA. — The Gorgas-Pierle Mfg. Company, 130 East Allen Street, manufacturer of oils of different kinds, will build a five-story brick and concrete addition to its plant, 75 x 155 ft., at 144-64 East Allen Street, to cost about $100,000. The Turner Concrete Steel Company, 1715 Sansom Street, has the contract for erection.

PHILADELPHIA. — Dungan Hood & Company, Inc., American Street, manufacturer of tanned, curried and finished leathers, has acquired a five-story factory at American and Diamond Streets, to be used for plant extensions.

PHILADELPHIA.—Fire, July 25, destroyed a portion of the oil works of the American Refining Company, Point Breeze, with loss estimated at $100,000. The plant will be immediately rebuilt. J. H. Van Dyke is president.

PHILADELPHIA.—Charles Lennig & Company, 112 South Front Street, will build a two-story, brick and steel addition, about 40 x 50 ft., to their chemical plant at Richmond Street and Delaware Avenue, to cost about $11,000.

PHILADELPHIA.—The Penn Paper Products Company, recently incorporated, has filed notice of organization at Camden, N. J., to operate its proposed plant in that city. LeRoy Jacobs, Philadelphia; and Cyrus E. Tomlinson, McKinley, Pa., head the company, which has an authorized capital of $50,000.

PHILADELPHIA. — The Barrett Mfg. Company, manufacturer of chemicals, has awarded a contract to the A. Raymond Raff Company, 1635 Thompson Street, for the construction of a one-story, concrete and brick addition, 87 x 100 ft., at Bermuda and Margaretta Streets, to cost $40,000.

PITTSBURGH.—The Pittsburgh Steel Products Company is planning a new plant, including a new town on Monongahela River. It is planned to expend about $3,000,000. Several farms in Allen township, opposite Fayette City, were purchased some time ago. A battery of blast furnaces, tube mills and other departments will be installed. The plant will have a river frontage of three miles. The president of the company is Willis F. McCook of Pittsburgh.

READING.—The Republic Color & Chemical Company, operating a number of plants in New England, will erect a factory here. The factory will include five buildings. John D. Esterly of Reading heads the company.

ST. MARYS.—The recent demand for electric furnace electrodes has come to the attention of the Stackpole Carbon Company at St. Marys, Pa., and their production department, after making many experiments, has developed a carbon graphite electrode, called "Stackpole Special," which has a high current-carrying capacity, and is being introduced extensively throughout the industries employing electric furnaces. The great demand for ordinary and special steels has brought about an intense demand for electrodes, and with the intention of meeting this demand the Stackpole Carbon Company has completed a large unit to their big plant, with the object of coming to the aid of the many who must have electrodes to operate. This new plant is equipped with machinery and furnaces to handle all sizes, both square and round, up to and including 17 inches in diameter.

At present the concern is daily producing large quantities of 4, 5 and 6-in. diameter electrodes. These are being made up of a composition which they have found offers a close substitute for graphite as regards the interchange of sizes, and it is interesting to note that these electrodes of a carbon graphite composition are being used in the place of graphite. The comparative diameters of the "Stackpole Special" electrode to the graphite is working successfully at 6 to 4, which fact is of engineering interest in view of the fact that so much smaller sizes as compared with the old carbon electrode can be used in the place of graphite. This ratio of diameters, when used, has given quicker heats with the same power consumption per ton in the case of the "Stackpole Special" than with the graphite, and confirms the production department's views that they have eventually solved the problem of the sort of electrode which will take care of the present shortage without resorting to the use of the old huge size carbon electrodes and consequent redesign of hundreds of electric furnaces.

Tennessee

BRISTOL.—Manufacturing will begin immediately in the new plant of the Chas. A. Schieren Company of New York City, built as an addition to its tannery at Bristol, Tenn. The buildings are entirely completed, and the equipment of machinery is being installed for the manufacture of the highest grade machine belts, the greater portion of which will be shipped to Southern plants. A working force sufficient to produce 24,000 lineal feet of belting daily will be employed at the start, and gradually added to, as skilled help can be secured, until the full capacity of the plant, 50,000 feet daily, is reached.

Texas

DENISON.—Construction work has begun on the mill and warehouses of the Peters Oil & Refining Company, to manufacture oil from peanuts. The mill building proper will be constructed of steel and brick, and will be 40 x 70 ft. The warehouses will be much larger than the mill, and will have a capacity of several hundred carloads of peanuts. The storage of peanuts will be large enough to insure operation of the plant throughout the year. The company, which was recently organized, will specialize in milling peanuts, beans and other vegetable products.

Utah

GUNNISON.—The Gunnison Valley Sugar Company is planning the erection of a sugar factory in this valley. It will have a capacity of 600 tons, and will be completed in time for the next year's crop. The company was recently organized, and is capitalized at $1,325,000. The officers are as follows: President, W. O. Kay; secretary, I. C. Thoreson, United States surveyor general for Utah; treasurer, W. H. Swanson, president of the Swanson Theater Circuit; additional directors, James P. Sprunt, Dr. A. C. Wherry, W. M. Johnson and Max Aniels. All of the officers are of Salt Lake.

SALT LAKE CITY.—Thomas B. Keeley of Chicago, who has a large number of patented iron ore claims in Iron County, and who owns 2100 acres of coal in the vicinity of Sunnyside, recently made an inspection of the properties and consulted with his engineers in regard to the advisability of erecting a steel plant near the Salt Lake City limits or on the shores of Utah Lake.

Virginia

IVANHOE.—The National Carbide Corporation of Bluefield, W. Va., will erect a plant here that will have an annual production of 15,000 tons of carbide. The plant will be built immediately, and will be completed within six months.

Washington

CENTRALIA.—R. Thomas of Portland, president of the Thomas Pulp & Paper Company, a $5,000,000 corporation just formed, announced that his company has completed arrangements for the erection of a 40,000 horse power plant and paper mill in Aberdeen. A new process of making all kinds of paper out of red fir has been invented by Mr. Thomas. The power plant will be located here. He says his company has purchased 300 acres of coal land in South Hanaford Valley and will mine its own coal, 500 tons of which will be needed daily.

SEATTLE.—A new corporation with a capital of $20,000,000 for building iron ore smelters, steel mills and blast furnaces on Lake Washington near Seattle, has been organized in San Francisco. It is possible that some of the iron ore will be obtained from Stevens County, northern Idaho and British Columbia. Some of the men interested are well known in Spokane, among them being William H. Crocker of San Francisco, who is interested with R. S. Talbot of Spokane in magnesite operations in Stevens County. Others who are said to be in the new organization are D. C. Jackling, William G. Devereaux, D. P. Hoak, S. F. B. Morse, B. L. Thane of San Francisco, and William Pigott of Seattle. Smelters, blast furnaces and steel mills will be built at Seattle, where the new company has 500 acres. The Pacific Improvement Company already has been given contracts for coal to be secured in Washington and which is said to be of a high coking quality. Gas ammonia, tar and other by-products will be manufactured.

Wisconsin

RACINE.—The Racine Rubber Company is building extensions to its works to increase the present capacity for the manufacture of automobile tires.

Canada

SUDBURY, ONT.—An enormous nickel smelter and refining plant will be constructed by the British-American Nickel Corporation about 4½ miles northwest of Sudbury. A large amount of Toronto capital will be invested in the new concern, though the British government controls $14,000,000 of the $20,000,000. It is estimated that within two years the corporation will be able to produce 6000 tons of refined nickel annually, and according to a statement made by E. P. Mathewson, general manager, the entire output is to go to the British government, the International Nickel Company being at the present time its chief source of supply.

Manufacturers' Notes

THE BYRON JACKSON IRON WORKS, San Francisco, Cal., has moved its general offices from 357 Market Street to the Sharon Building, on New Montgomery Street, directly opposite the Palace Hotel.

ELECTRIC HOISTS.—The Link-Belt Company, with factories in Chicago, Philadelphia and Indianapolis, and sales offices in the principal cities of the country, announces its ability to again furnish Link-Belt Mono-rail electric hoists for quick shipment. These machines are made at the Philadelphia plant, where a large additional building is rapidly nearing completion and the present manufacturing facilities are being greatly increased. Both types, C-1 and C-2, can be furnished, the safe lifting capacities ranging from 1000 lb. to 6000 lb. They can be adapted for either direct or alternating current and fitted with plain, hand-geared, cord-operated motor, or a cage operated motor trolley.

FEDERAL TRADE COMMISSION'S COPPER COST INVESTIGATION NEARING COMPLETION.—The Federal Trade Commission's investigation into the cost of producing copper, under supervision of Commissioner Colver, is progressing favorably. Dr. L. H. Haney is in direct charge of the details of this phase of the commission's investigation of metal costs. The field reports are now coming in rapidly and the commission hopes to have all reports in and results ready for submittal to the President within another week. None of these figures will be given out at the commission. If given out at all they will be made public at the White House.

THE GLENS FALLS MACHINE WORKS, which have been making a successful sulphur burner at Glens Falls, N. Y., have consolidated with the F. R. Patch Manufacturing Co., Rutland, Vt. The business of the Glens Falls concern will be carried on under the old name, the offices remaining at Glens Falls, except the treasurer's office, which will be at Rutland. The officers are: President, F. R. Patch; vice-president, Newman K. Chaffee; treasurer, George C. Cobb; secretary, E. A. Hall; works manager, Fred B. Chappell. Their products consist of the Tromblee & Faull rotary sulphur burner, Monarch rotary screen, A. D. Wood pulp washers, slushers, water filters and save-alls, Standard wet machines, Standard ground wood wet machines, wood pulp grinders, rotary pumps, etc. In addition to the works at Glens Falls the consolidation gives the organization a large modern plant in Rutland employing from 250 to 300 men, and increases the producing capacity about three times.

CLEANING INDIA INK FROM TRACING CLOTH.—An article manufactured by E. H. Anderson at 272 East 199th Street, New York, under the name of "Rasindia" is claimed to completely clean India ink from tracing cloth, without injuring the cloth.

C. W. LEAVITT & CO., 30 Church Street New York, as buying agents for foreign clients, are interested in receiving catalogs and quotations for export, on oil- and tar-heated furnaces for tempering and anneal-

ing steel. Also covering furnaces for hardening tool or high-speed steel, and pyrometers and other apparatus useful in the production of high-grade steel.

CORRECTION ON GENERAL BAKELITE CO.—In our last issue (Aug. 1), page 150, under Perth Amboy, N. J., it was stated in a notice of an addition to its plant that the General Bakelite Co. was a subsidiary of the Roessler & Hasslacher Chemical Co. This statement is incorrect as the General Bakelite Co. is an entirely separate company and not controlled by any other company. The general offices are at 2 Rector St., New York City.

HUMIDITY AND DEW POINT PATENT.—The Buffalo Forge Company, Buffalo, N. Y., has issued a statement that the United States District Court has recently sustained the Carrier patent on its dew point and humidity control.

"Suit was brought against the City of Buffalo and Thomas & Smith, Inc., contractors on two installations which the Buffalo Forge Company claimed to be infringements on the Carrier patent.

"The claims cover the automatic regulation of humidity, so as to maintain a constant dew point or saturated temperature by means of bringing air into intimate contact with water heated above the temperature of the water to accomplish the desired result, i. e., the water temperature is variable so as to produce a constant saturated temperature of the outgoing air.

"The court holds that it is not essential that this water should be sprayed into the air, since the defendant's infringements consisted of a tank of hot water which, overflowing, mingled with the unheated water from the spray nozzles, thereby producing the intimate mixture which our patent covers.

"The Buffalo Forge Company consider that heated spray water at a variable temperature, which is controlled by thermostat at the bottom of the eliminator, is an infringement, but a thermostat submerged in the middle of a tank does not infringe, as this would tend to keep a constant temperature of the spray water at a variable temperature with a *constant water temperature* the air temperature would vary from time to time—and humidity control could only be obtained with an additional thermostat.

INDUSTRIAL ALCOHOL DIVIDENDS. Directors of the United States Industrial Alcohol Company at their meeting Aug. 2, declared a cash dividend of 16 per cent on the common stock for the year 1916, a dividend of 10 per cent for the current year, and indicated that hereafter annual dividends of 16 per cent would be distributed.

The first 16 per cent dividend is payable out of surplus accumulated prior to Dec. 31, 1916, and will be paid on Oct. 1 to stockholders of record on Aug. 20, while the second disbursement of 16 per cent, which is for the year 1917, is payable Dec. 1 to stockholders of record on Oct. 20.

The operating income of the United States Industrial Alcohol Company in 1916 amounted to $6,727,043. The net income was $4,884,587, and after payment of 7 per cent dividends on the preferred stock, which has ruled since 1907, the year following the company's organization, the surplus remaining for dividends on the common was $4,336,025. This amounted to 36.14 per cent on the $12,000,000 of common stock.

In the last seven years the company has earned an average of 9.39 per cent. on its common stock, but in recent years the profits have been far above the average. The figure 36.14 per cent for 1916 compares with 12.6 in 1915, and 1.94 in 1914. The expansion in the company's business has been due to the war, with its demand for high explosives, in the manufacture of which alcohol is essential.

"The company's building and development program has now been practically completed," stated Horatio S. Rubens, chairman of the Board of Directors, in announcing the dividend. "The floating indebtedness of the company has been extinguished and the output for the current year has been satisfactorily and firmly sold. The company has set aside out of earnings for the first half of 1917 the sum of $1,500,000 as a reserve to cover Federal corporation taxes. It was decided to declare a dividend at a rate which, it now seems reasonable to expect, can be maintained under after-war conditions, owing to the entry of the company and its various subsidiaries into additional fields of production, which promise to be profitable under peace conditions."

The company erected the largest distillery in the world at Baltimore last year, in order to take advantage of the war business, and also, at the same time, embarked on the manufacture of acetone, which is used in the manufacture of munitions of various descriptions. The company was able, it is understood, to obtain European contracts for its enlarged output on highly favorable terms, and since the entry of the United States into the war it has been gossip that its orders from the United States Government have been enormous.

AMERICAN BRASS ENTERS BUFFALO.—The Buffalo Copper & Brass Rolling Mill has been sold to the American Brass Company. The plant was taken over by the new owners on July 1 and increased operations will be started as soon as possible.

Announcement of the transaction was made a short time ago by William A. Morgan, president of the Buffalo company. The purchase price was not made public. Charles F. Brooker, president, represented the American Brass Company.

As Mr. Brooker is chairman of the brass committee of the National Defense Board, it is expected the plant will have much to do with the manufacture of brass products for the Government.

The Buffalo plant is the latest addition to the series owned and controlled by the American Brass Company. The concern operates three plants in Waterbury, Conn., two plants in Ansonia, Conn., one in Torrington, Conn., and one in Kenosha, Wis.

It is said special inducements were made by the city of Cleveland to have the brass corporation settle there, but Mr. Morgan drew the officers' attention to this city.

The advent of the American Brass Company into the industrial field of Buffalo is looked upon with favor by local manufacturers. It insures the permanency of the industry which Mr. Morgan has built in three years from a small foundry to an industry which now employs more than 5,000 men.

This Buffalo company has been engaged in the manufacture of brass products for foreign governments for almost three years. When the foreign business began to drop Mr. Morgan thought it best to transfer his plant to an organization which is especially trained for home business.

TO OPEN WASHINGTON OFFICE.—The Jones & Laughlin Steel Co., Pittsburgh, has opened a district sales office in the Woodward Building, Washington, D. C., in charge of H. F. Holloway, who is district sales manager of the New York office of the company, and who will also hold the same title in the new Washington office. Mr. Holloway will be assisted by Ralph T. Rowles, who was formerly connected with the Philadelphia office, and covered the Washington, D. C., field. Mr. Rowles will now have his headquarters in the Washington office.

BON AIR COAL & IRON CHANGES HANDS.—The Bon Air Coal & Iron Corporation will be organized with a capital of $10,000,000 to take over the Bon Air Coal & Iron Co.'s properties at Allen's Creek, Eastland, Bon Air and Ravenscroft, Tenn., which have been in receivers' hands for seven years. The new company plans to improve the two stacks and six Gordon hot-blast stoves which the old company operated at Allen's Creek and will add two more stoves, increasing the output to 200 tons a day. At Eastland the company had 200 beehive ovens which produced 80,000 tons of coke a year. The coal mines of the corporation are located at Bon Air, Ravenscroft and Eastland, and it is the purpose of the new owners to increase the output of coal to 10,000 tons a day. Included in the purchase are 27,000 acres of timber land in Wayne County, Tenn., and this property is reported to contain rich ore deposits which will be developed later. The officers of the Bon Air Coal & Iron Corporation are Alex. R. Peacock, New York, president; W. J. Cummins, Nashville, vice-president; A. J. Moreland, Pittsburgh, secretary and general manager; John McE. Bowman, New York, treasurer and chairman. Mr. Peacock was formerly vice-president and sales manager of the Carnegie Steel Co., and Mr. Moreland was formerly connected with the same company. Mr. Bowman is a leading New York hotel man.

ONTARIO POWER CHANGES HANDS.—The Provincial Hydro Electric Commission of Ontario has taken over the plant of the Ontario Power Co., at Niagara Falls, Ont. The plant was recently purchased by the Commission at $22,000,000, of which $13,000,000 is represented in bonded indebtedness to the company, and it is understood, will form an important link in the Chippawa Creek-Queenston Heights development scheme, the ultimate capacity of which will be 900,000 hp. The Ontario Development Co. has a franchise development of 180,000 hp.

Manufacturers' Catalogs

THE B. F. GOODRICH COMPANY, Akron, Ohio, has issued an attractive booklet on rubber goods for mining, describing a wide variety of rubber products.

THE ELECTRIC WEIGHING COMPANY, 180 Thirteenth Avenue, New York, has issued Bulletin No. 10, describing Messiter Conveyor Scales for automatic weighing.

CHAS. A. SCHIEREN COMPANY, Cliff and Ferry Streets, New York, has issued a Belt Buyers' Guide containing valuable practical information on the use and care of belts.

AMERICAN STEEL EXPORT COMPANY, Woolworth Building, New York, has issued a booklet entitled "Export Engineering and Contracting."

CHICAGO PNEUMATIC TOOL COMPANY, Fisher Building, Chicago, has issued Bulletin 137 describing the Chicago Giant rock drill, tappet type.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y., has issued a comprehensive booklet on hoisting machinery for industrial works.

TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y., has issued a booklet on Tycos base metal thermo electric pyrometers.

PALO COMPANY, 90 Maiden Lane, New York, has issued a pamphlet describing the Hess-Ives Tint Photometer.

ROBINS CONVEYING BELT COMPANY, 13 Park Row, New York, has issued a handbook of conveyor practice giving considerable valuable information.

PITTSBURGH INSTRUMENT & MACHINE CO., 101 Water Street, Pittsburgh, Pa., has issued a pamphlet describing the Pittsburgh Metal Sheet Tester.

FRUEHAUF TRAILER CO., Detroit, Mich., has issued a booklet on the Fruehauf trailer for carrying up to 10 tons.

HARDINGE CONICAL MILL CO., 120 Broadway, New York, has issued catalog No. 7, Section 1, giving general information on Hardinge mills.

F. J. STOKES MACHINE CO., Philadelphia, Pa., has issued an attractive catalog on vacuum dryers and chemical apparatus.

Other New Publications

COKING OF ILLINOIS COALS. By F. K. Ovitz. Co-operative investigation of Bureau of Mines and Illinois State Geological Survey. Issued as Bureau of Mines Bulletin 138.

ANSWERS TO QUESTIONS ON THE FLOTATION OF ORES. By Oliver C. Ralston. Bureau of Mines Technical Paper 149.

BIBLIOGRAPHY OF THE GEOLOGY AND MINING INTERESTS OF THE BLACK HILLS REGION. By C. C. O'Harra. South Dakota School of Mines Bulletin No. 11. Rapid City, S. D.

ORIGIN AND OBJECTS OF THE RESEARCH CORPORATION. Issued by the corporation, 63 Wall Street, New York.

PLATINUM AND ALLIED METALS IN 1916. By James M. Hill. Geological Survey Bulletin.

LITHIUM MINERALS IN 1916. By Waldemar T. Schaller. Geological Survey Bulletin.

WHAT SHOULD A PRESENT-DAY METALLURGICAL EDUCATION COMPRISE? By C. H. Fulton of Case School of Applied Science. Published by School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

CONGRESS OF HUMAN ENGINEERING. Oct. 26, 27 and 28, 1916. Published by Ohio State University, Columbus, Ohio.

PERMISSIBLE EXPLOSIVES. Tested prior to Jan. 1, 1917. By Spencer P. Howell. Bureau of Mines Technical Paper 169.

AMERICAN FERTILIZER HANDBOOK. 1917. Tenth annual edition. Published by Ware Bros. Co., Philadelphia, Pa.

THE PRIMARY VOLATILE PRODUCTS OF THE CARBONIZATION OF COAL. By Guy B. Taylor and Horace C. Porter. Bureau of Mines Technical Paper 140.

ASBESTOS IN 1916 By J. F. Diller. A Department of the Interior publication, published July 21, 1917.

TALC AND SOAPSTONE IN 1916. By J. S. Diller. A Department of the Interior publication, published July 21, 1917.

PREPARATION OF FERRO-URANIUM. By H. W. Gillett and E. L. Mack. Technical Paper 177, Mineral Technology 21, issued by the Department of the Interior, Bureau of Mines, Washington, D. C.

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President Wilson's Reply to the Pope

"We seek no material advantage of any kind. We believe that the intolerable wrongs done in this war by the furious and brutal power of the Imperial German Government ought to be repaired, but not at the expense of the sovereignty of any people—rather a vindication of the sovereignty both of those that are weak and of those that are strong. Punitive damages, the dismemberment of empires, the establishment of selfish and exclusive economic leagues, we deem inexpedient, and in the end worse than futile, no proper basis for a peace of any kind, least of all for an enduring peace. That must be based upon justice and fairness and the common rights of mankind.

"We cannot take the word of the present rulers of Germany as a guarantee of anything that is to endure unless explicitly supported by such conclusive evidence of the will and purpose of the German people themselves as the other peoples of the world would be justified in accepting. Without such guarantees, treaties of settlement, agreements for disarmament, covenants to set up arbitration in the place of force, territorial adjustments, reconstitutions of small nations, if made with the German government, no man, no nation, could now depend on."

Amen! So mote it be!

Particular Phases in the Present Labor Situation

The present labor situation, in its broadest sense, is a mixed up and complicated affair. Not being characterized by a single pre-eminent idea or tendency, it exhibits rather a number of peculiar isolated phases which apparently have little to do with each other and yet must be more or less interconnected. Neither between different industries, nor between different branches of the same industry, can a straight standard of comparison in the form of a unit of salary be employed.

In these columns we have alluded before to the fact that young chemical graduates are now able to draw a monthly salary of $200 in certain industries prospering on account of the war. Whether this is a good thing for them, or not, is very hard to decide in general. But it is just as true that there are classes of hard-working, earnest, able and competent chemists whose salaries have been raised but little, if at all, by the war. This may seem "unfair," but the reason will be understood when it is considered that the selling price of a chemical training, as an economic commodity, depends on various factors, a great many more just now than a few years ago.

It is said that the economic value of an article for sale consists of form value, place value, and time value.

Form value is the value contributed by the manufacturer by changing the raw material into the finished product. Place value depends on transportation; time value on storage possibilities. The classical illustration of the latter two is ice; ice in the Maine woods in winter has no economic value, because nobody is willing to pay money for it there and then; brought to New York, the ice acquires place value; and if it is stored for sale in summer, it acquires additional value—time value.

If a student acquires a thorough chemical training he becomes in certain respects a new man (form value); his training enables him to carry out those processes which comprise the field of chemical technology, and because a knowledge of this correct application of chemical technology is of greatest importance in very many industries at present, the form value of a chemical training as an economic commodity has increased; the average salary of a chemist for the same work done has gone up. This has been true for quite a series of years, but in the last few years place value and time value have attained additional importance.

Place value has become important because the number of positions in which chemical training can be profitably employed has very greatly increased. It is now much easier to take a chemical training to some other place for financial exploitation; we only need remember the recent exodus of the chemical professors from the universities to the industries. We do not want to discuss how bad or good this will be for chemistry in the long run, our only object was to state the facts and their relation to the "chemical labor market." The consideration of "time value," on the other hand, acts somewhat like a balance wheel. It is rather risky now to rely on the permanency of some of those high-salaried war positions. And this uncertainty as to shifting from one position to an equally well or better salaried hypothetical position some time in the future is an important element in shaping the future labor market. For a new chemical labor market is now in the making.

Now let us turn for a moment to an entirely different and new problem of the metallurgical labor market. For many years the iron and steel industry of this country has depended to a large and essential extent on immigrant labor. When this was shut off by the war a substitute had to be found, and it was found in colored labor imported from the South. The Steel Corporation is said to have adopted this remedy first, and the independents to have followed suit. But the historical details do not matter. The principal fact is that the operating men of the iron and steel industry will have a new problem on their hands when the war is over—the race problem. For various recent occurrences have made it once more clear that this country has a race problem, and that it is nowhere near solved.

When the war ends, the whole aspect of the labor situation will be completely changed. But whether the war ends soon or not, it will pay now to watch intelligently any new particular phase coming up in the labor situation.

Allotting the Steel Output

While the steel manufacturers evince what may be described as an indisposition to sell steel to our European Allies at the prices to be paid by our own Government, they are vigorously opposed to the "one price for all" doctrine as regards sales to ordinary domestic consumers. They assert, in the first place, that "it can't be done," and follow this apparently conclusive dictum with other arguments, possibly forgetful of the fact that last February there was opposition to the naming of special prices to the Government on the ground that this would bring down the outside market, as ordinary consumers would refuse to pay more than the Government, they being supposed to remember our Government's liberality in purchasing supplies for the Spanish-American War.

There are two opposite views as to the future of the steel demand, say over the next twelvemonth, one being that there will be a continued shortage of steel, and the other that there will be an ample supply after the present pressure has experienced further relief. If the first view prove correct, regulation of steel deliveries will be highly desirable; if the latter, no particular harm could result from the work having been undertaken.

President Wilson's appeal of July 12 that there should be "one price for all" was predicated on the view that we are all engaged in the war and all must be protected from contributing abnormal profits to producers, whether of coal, of steel, or what not. This would be true if it were possible to allot a share of the war work to every one in the country, and every one was doing the work allotted to him, but such is not the case and cannot be the case. If it were, the country would not be consuming an amount of steel equal to the capacity minus the tonnage required by our Government and our Allies.

The fact is that the activities of the people consuming steel represent wide variations of indispensibility. The users of steel pass by almost infinitesimal gradations from direct connection with the war to a position diametrically opposed to its most efficient prosecution. One man may build farm machinery which will help to increase next year's crops, while another may wish to build a department store, to employ men, when the existing stores, under the kind patronage of Washington, are asking their customers to carry home their parcels and release drivers to go to the front.

In these circumstances it is clear that if the Government is interested in the prices the domestic consumers of steel are to be expected to pay it should be still more interested in the matter of who is to receive preferential treatment in deliveries. It would not be difficult to set up a general set of rules to govern deliveries. Certain questions might be asked: Will it help prosecute the war? How much and what kind of labor will its fabrication or employment involve? What inconvenience would result if the delivery were delayed three months? Six months? The steel mills, as a rule, are quite familiar with the operations of their customers, and at all times the great majority of mills

make a serious and intelligent effort to distribute their steel in such manner as to keep the wheels of industry moving. They would be in excellent position to co-operate with the Government were a set of rules established for the distribution of the steel.

One of two things will occur. Either the matter of steel prices will be left to the open market for settlement, or there will be legislation, as there has already been for "food, feed and fuel," empowering the administration to fix the schedule. In the former case it is obvious that the buyer who bids the highest price is no more likely than not to be the one who will use the steel to best advantage in furthering the work of war. The steel may easily be a selfish luxury for him. In the latter case, regulation of deliveries is absolutely necessary, because otherwise the distribution would be left to the chance of the man who made the earliest purchases.

We referred a month ago to the fact that the friction, the unfavorable items about the conduct of the war, are kept ever before us, while of the actual accomplishments little or nothing is said. The observation is applicable also to the relations between the steel industry and the Government. The Washington dispatches are full of the "controversy" over steel prices. Scarcely anything is said of one magnificent piece of work that has been carried out by purely co-operative methods, Washington having technically no authority whatever. In the early stage of the war preparations it became apparent that it would be desirable to encourage canning the maximum amount of the perishable crops. The Government had no occasion to buy tin plate or to regulate its distribution, but it requested the tin-plate mills to divert to the perishable food products all the tin plate that could possibly be used. The mills did so. They passed up opportunities to sell tin plate at fancy prices. They explained to customers who used tin plate for other purposes that they would have to wait, and the other customers have waited. At the beginning of July the authorities at Washington saw that the situation as to perishable foods was well in hand, and authorized the mills to extend their deliveries to packers of non-perishable foods, and this in turn was done. The tin-plate makers even suggested to customers who were asked to wait that they experiment with fiber containers, knowing full well that some of them might never return to tin plate. All this was done with a minimum of friction and of publicity. It furnishes a lesson as to what can be done on a vastly broader scale with steel products in general if the work is taken up in the proper manner.

Save the Sulphuric Acid

To the man on the street the fact that there is a shortage in sulphuric acid seems hardly worthy of remark; it is immediately classed with those countless other stringencies, real, artificial or bogy, bestirring themselves to pester these troublous times. But the technical man, whether or not an acid user, cannot help but blink when he learns that during the next twelve months the United States is expected to produce eight million tons of acid, with sulphur in sight for only five.

A largely increased demand for sulphuric acid has resulted from the extraordinary expansion of our chemical and explosives industries; a largely decreased supply of sulphur has resulted from the U-boat menace. Formerly, empty shipping returning to America would bring as ballast at the very lowest rates, cheap Spanish pyritic ores, much of which had been mined and leached especially for its copper content. No more shipping, no more foreign pyrite. Even the embargo stopping Canadian paper-makers' supply of sulphur will have small effect on the situation, even though it causes frenzied distress signals from that great American extravagance labeled "Fifth Extra."

Expected shortages might be met by increased production. Mining engineers are not very sanguine of the possibility of getting much more sulphur from the wells of Louisiana, nor of a quick increase in pyrite mining in the Appalachian region—for the acid works are built close to the docks, now bare of Spanish ore, and to the consumers, now with an apparently insatiable appetite.

It is a matter of great regret that the untold quantities of sulphides mined and smelted in the Mississippi Valley and Rocky Mountains cannot permanently furnish our needed sulphur. While approximately one and a half million tons of acid are now made from roaster gases, this is about all that the local market will absorb in the smelter regions, and acid is bulky and cheap and will not normally stand heavy freight charges. Abnormal conditions cannot produce additional acid-making capacity instantly, nor even after a term unless the maker is assured of writing off his plant-cost before the end of the boom. Nor is the time ripe to consider smelter smoke as a source of elemental sulphur, and some other projects for getting the "weak atom" of sulphur from pyritic ores are in the formative stage.

It does seem, however, that a very large amount of liquid sulphur dioxide could be recovered from flue gases by easily constructed plants after the well-established method mentioned in Mr. Ridge's article on page 221. This could readily supply the entire sulphite requirements of paper-pulp makers, who should be glad to use it, now that Louisiana sulphur is so scarce and expensive. A very pure product could be made, especially at plants which precipitate the fume from the flue gases.

Lacking a necessary supply, the next step is to use substitutes and to economize in the use of indispensable acids. In the latter case, especially, the chemical engineers can do much in insisting upon saving and concentrating the enormous amounts of partially spent acid daily running to waste. On the other hand, metallurgists can eliminate practically all fresh acid from their pickling baths, by the use of the acid sodium sulphate from niter cake. Many articles really do not need pickling at all, while many more could be as efficiently and economically cleaned by rumbling, sand blasting or electrolysis.

Readers' Views and Comments

A Criticism of the Chemical Exposition

To the Editor of Metallurgical & Chemical Engineering

Sir:—The Second Exposition of Chemical Industries was pronounced a decided success, and now the third is soon to be opened. There is no doubt but the third show will be a success as well, but there is also no doubt that it will be more of a success if any features can be avoided that have been a source of dissatisfaction in the past. Of course, it is a physical impossibility to carry out anything on such a large scale as this without an occasional visitor being dissatisfied with something or other, but at the last show one feature confronted me with such persistence that I cannot help thinking that it must have been a source of annoyance to others as well, and that it ought to be called to the attention of the general body of exhibitors at the show.

The object of these expositions, as I understand it, is mainly to advertise the products of the exhibitor and to bring the buyer and seller into closer relations with each other. Of the two, the latter seems to me the more important, and to the extent that the exposition fails to accomplish this end it is a failure.

I came to the exposition last year very much interested in three particular things. Of course, I went over the entire show, and was in a large proportion of the booths of the various exhibitors, but these three materials were my main items of interest. I went to the booth of one of the leading jobbers that had the first of these materials on exhibition, and after some discussion of the matter stated that I wanted to leave an order. The attendant, after fumbling around through a number of papers, announced that he had no quotations on what I wanted, and that it would be better if I filed a request for a quotation and then sent my order on receipt of quotation. I did so, but it has been over ten months, and the quotation has not yet arrived.

I went to a second booth, and, after some inquiries concerning the suitability of their product for the work that I had in mind, I left with them an order for a small quantity of their product for trial. That also was ten months ago, but the material has not yet been received.

At a third booth I explained that I was doing some experimental work for which I needed certain of their products, and left an order. That material also is still to arrive.

In every case the material ordered was standard goods, regularly carried in stock, and on exhibition in the booth. None of it was to be special in any way.

Does not a 100 per cent failure at least give one a reasonable excuse for complaint?

South Bethlehem, Pa. G. A. Roush.

Determination of Chromium and Vanadium in Steel

To the Editor of Metallurgical & Chemical Engineering

Sir:—The determination of vanadium in presence of iron and chromium has proven rather difficult for routine work. The method herein described has proven satisfactory both for accuracy and speed. Credit for priority for the determination of chromium is due to Phillips (*Stahl und Eisen*, Vol. XXVII, pages 1164 to 1167) and H. E. Walters (Metallurgical and Chemical Engineering, Vol. XII, No. 5, page 310). The determination of vanadium is made after chromium has been oxidized. The vanadium is reduced by ferrous sulphate, the excess of which is oxidized by ammonium persulphate. The vanadium is then oxidized by standard potassium permanganate, from which the percentage of vanadium can readily be calculated. The details follow:

CHROMIUM

Two grams of the sample are transferred to a 600 c.c. beaker, and 60 c.c. sulphuric acid and silver nitrate mixture added. Heat is then applied until all action ceases. If vanadium is present 5 c.c. of syrup of phosphoric acid are added. Then 10 c.c. of nitric acid (1.20 sp. gr.) are added and the solution is boiled until the fumes are expelled. The contents of the beaker are then diluted to a volume of approximately 300 c.c. with boiling water, the solution then heated to boiling, and 10 c.c. ammonium persulphate solution added. After the permanganate color has developed, 1 c.c. of conc. hydrochloric acid is added, and boiling continued until the pink color disappears and until persulphate is expelled (about ten minutes). Then the solution is cooled, diluted with water to approximately 400 c.c., and the chromium is determined by titration with standard ferrous ammonium sulphate and standard potassium permanganate. Ferrous ammonium sulphate solution is added until chromium is reduced (50 c.c. from pipette). Standard potassium permangate solution is added from a burette until the solution assumes a pink color which does not fade upon continued stirring. If vanadium is present the pink color will slowly fade, owing to the slow reoxidation of the vanadium. When the vanadium is completely oxidized, however, a pink color lasting one minute is obtained, which is the end point.

The per cent of chromium is obtained by conducting a blank titration on the ferrous ammonium sulphate solution, the same volume of water being used. The difference in cubic centimeters between the volumes of permanganate solution required in the actual determinations represents the volume of permanganate equivalent to the chromium in the steel, and is multiplied by the value of 1 c.c. of permanganate solution in terms of chromium.

VANADIUM

After the chromium has been determined, 5 c.c. of $\frac{N}{20}$ approximately — ferrous ammonium sulphate are added. The contents of the beaker are then stirred thoroughly, after which 10 c.c. of ammonium persulphate (20 per cent solution) are added, stirring continually for about one minute. Potassium permanganate (0.03922 N) is then slowly added until a pink end point that remains after one minute's stirring is obtained. Each cubic centimeter used is equivalent to 0.1 per cent vanadium when 2 grams of the sample are taken for analysis.

A blank determination should be made either on plain steel or on steel containing about the same chromium

content as the sample being analyzed. The blank obtained is equivalent to from 0.02 to 0.03 per cent vanadium and is constant. The ferrous ammonium sulphate and ammonium persulphate is sufficient to take care of vanadium as high as 0.60 per cent; for higher vanadium more of the above chemicals should be added.

SOLUTIONS FOR CHROMIUM

Potassium permanganate, 3.61 grams; water, 1000 c.c. One cubic centimeter of normal potassium permanganate equals 0.01733 gram chromium, but potassium permanganate equals 1 per cent of the chromium required to overcome the green color of chromic sulphate in solution. Therefore 0.0175 times the normality of the permanganate divided by 2 (2-gram sample taken for analysis) and multiplied by 100 gives the value of 1 c.c. of potassium permanganate in terms of chromium.

Sulphuric acid-silver nitrate mixture: Silver nitrate, 5.5 grams; water 330 c.c.; sulphuric acid (1:1), 670 c.c.

Ferrous ammonium sulphate, 19.6 grams; water, 900 c.c.; sulphuric acid (1:1), 100 c.c.

SOLUTION FOR VANADIUM

Potassium permanganate, 1.24 grams; water, 1000 c.c. One c.c. equals 0.1 per cent vanadium when 2 grams sample are taken for analysis.

Carnegie Steel Co.,
Duquesne, Pa.

H. L. HAMNER.

Western Metallurgical Field

Improvements in Tungsten Recovery.

Several changes in the dressing of tungsten ores as practised in the Boulder, Col., region, have occurred since the publication of the articles in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XVI, pp. 559 to 565, and Vol. XVII, pp. 73 to 78.

The step generally considered most important at all mills is the prevention of sliming at the start of milling operations. While this trend was felt early in this year it at present amounts practically to a mania among the mill men, and stamps and sliming mills are being rapidly replaced by non-sliming rolls. The saving of the maximum amount of the values before fine grinding is now one of the constant endeavors of the operators of the Boulder district.

At the present several mills are contemplating a separate treatment of all middlings. The middlings are collected in bins and when a sufficient quantity of this material has accumulated it will be treated in a distinct department. This is a very wise move. Previous practice has been to return these middlings to the head of the mill and let them pass through a second time, which, as is readily seen, is a useless waste of power and capacity.

The Vasco mill has materially cut down the feed to the rag plant by a concentration on Deister tables. These tables give a 60 per cent concentrate, which is shipped directly. The management has not yet decided what to do with the middlings, but in all probability they will be collected and treated in a separate unit. Only the tailings from the Deisters go to the rag plant, enabling the company to cut down its rag plant area.

An entirely new method is used by the Tungsten Products Company. This company treats custom ores, jig concentrates, table concentrates or any other material they can purchase. The material is first very carefully graded by screening on 20, 40, 60, 80 and +150 mesh sieves of the impact type. All sized material is then treated by a three-magnet Wetherill Separator. The flux used varies somewhat, depending on the size and the nature of the product.

The material is fed to the belt by a mechanical feeder and evenly distributed by means of a rotating brush. The feed is rather thin, due principally to the small amount of available material; the plant handles only 5 tons per day. The ore then passes under the first magnet, which operates on a low amperage, and which eliminates most of the iron contained on the belt at its two poles. The amperage passing through the second magnet is about 3.5 amp. At its leading pole an iron silicate is removed, while at the other pole some of the tungsten is caught. Most of the tungsten, however, is obtained from poles of a third magnet whose amperage is 7. The tailings drop over the end of the belt and consist mainly of silica and pyrites. Between and underneath the second and third magnets are brushes which assist in removing the small quantities of tungsten retained on the belt. The concentrates obtained from this magnetic separation are of a high grade, low in magnetic iron oxide, pyrites and silica.

Half-Yearly Metal Production

During the year 1917, up to the end of June, all the copper mines and smelters in Arizona had been producing at capacity, with very little interruption other than a strike at Jerome, according to information gathered by the U. S. Geological Survey. Labor troubles developed widespread curtailment of production, and an expected record production of more than 700,000,000 lb. has been defeated, for since that time every producer in the state has been seriously curtailed, some being shut down as long as five weeks, while the Clifton-Morenci district is still idle.

During the first six months of 1917 every effort was made at Idaho mines to equal the unusual record of the year 1916. The value of the output in that year was $48,767,783, and for months after the close of the year the prices of silver, copper, and lead were decidedly higher. The shipments from the Coeur d'Alene region, which give an idea of conditions in Idaho, were maintaining the rate of the previous year, which was nearly 44,000 tons of crude ore and concentrates per month.

The silver, copper, and lead output of Nevada in 1917 will probably show an increase over the output of the previous year, but no improvement is expected in gold, the production of which has been steadily declining for the last few years, and little change will be made in the zinc output. Many old mines and prospects became productive when metal prices reached a point permitting long hauls to the railroads.

Montana mines made a large output of silver, copper, and zinc during the first six months of 1917, even if they were delayed to some extent by the severe winter and by fire in the mines at Butte. As the six months' period closed a multitude of intricate labor troubles broke out, at one time threatening a bloody reign of terror, and causing extreme losses in metal production.

The trouble in Butte was no sooner patched up than a strike broke out among the smeltermen at the Washoe plant, and at this writing the Anaconda Copper Mining Co. have closed all their operations in Montana.

The unusually severe winter of 1916-17 reduced the production of the mines of Utah so much that the State's output of all metals in the first six months of 1917 will not exceed that of 1916. Many of the mining camps were at times isolated by snowslides, which blocked the transportation of ore from Park City, Tintic, and the Cottonwood districts. Ore received at the smelters from the mines outside of Utah accumulated in the railroad yards and unloading was delayed on account of freezing in the cars. Then a prolonged shortage of coal and coke caused smelters and mines alike to be operated at reduced capacity. As a climax, a strike for an increase in wages closed for a short time one of the large smelting plants. Extensive improvements and enlargements of smelters and milling plants in the State indicate a greater production in the second half, which may offset any decrease during the first six months.

Although the receipts from Oregon at the mint and smelters at San Francisco show a falling off in output of gold for Oregon of some $75,000 for the first five months of 1917, as compared with the corresponding period of 1916, it is not an indication that the mines, as a whole, are less prosperous this year than last.

While the general mineral industry of California has shown exceptional activity for the first six months of 1917, as compared with the conditions in the first half of 1916, gold mining has been suffering a period of depression. The United States Mint at San Francisco, and local smelters and refiners, are in receipt of about the same quantity of gold and silver in the first five months of 1917 as in the corresponding period of 1916, proving that no advance in output has been made, notwithstanding the opening of new gold mines and reopening of old ones.

Power Hearing in California

The California Railroad Commission has instituted on its own motion an investigation into rates, rules and practices of the Great Western Power Company, the Sierra & San Francisco Power Company and the Pacific Gas & Electric Company as applied to the proposed plant of the Pacific Electro Metals Company. The last-named company was organized recently to build and operate a five-hundred-thousand-dollar plant for reducing and refining metals on San Francisco Bay. Complaint was made to the commission that when the power companies were asked for rates on approximately 10,000 hp. two companies quoted $36 per horsepower-year and one $40 per horse-power-year. The Pacific Electro Metals Company asserts that a rate of $15 is sufficient for this class of business.

The early examination of officials, engineers and rate experts from the three power companies produced a formidable collection of statistics. There is general agreement on the importance of the principles of rate making which are involved.

After the examination of the power company officials has been completed the commission will present the results of its study of the matter. This will be accompanied by a map showing the transmission lines of the state and suggesting means of combining them so as to cut down the cost of service, reduce the steam standby charges and conserve power resources generally.

Meanwhile construction is actively under way on the Pacific Electro Metals plant at Bay Point.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15.

National Safety Council, New York, Sept. 10-15, 1917.

National Exposition of Safety and Sanitation, New York, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 24-29, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

Technical Association of the Pulp and Paper Industry.—Joint meeting with the Technical Section of the Canadian Pulp and Paper Association, Holyoke, Mass., Sept. 27 to 29, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Program of Fall Meeting of American Electrochemical Society

One of the features of the Pittsburgh meeting to be held from Wednesday, Oct. 3, to Saturday, Oct. 6, will be a session devoted to the application of electrochemistry and electric furnaces to the manufacture of war supplies and munitions. Some of the members who have been taking an active part in the Advisory work in connection with National Preparedness have been asked to take part in this symposium and it is expected that it will prove one of the most interesting features of the Pittsburgh meeting. Touching as it does on the needs of our country at the present moment, it will add considerable patriotic as well as scientific interest to the meeting.

It is earnestly requested that any members who can add even a short discussion to this symposium communicate at once with the chairman of the Local Papers Committee, Mr. R. E. Zimmerman, assistant director, Research Laboratory, American Sheet & Tin Plate Company, 210 Semple Street, Pittsburgh, Pa. The general discussion will of course be open to the entire membership.

PROGRAM OF THE MEETING

Wednesday, Oct. 3.

Automobile trip from headquarters, Wm. Penn Hotel, at 1 p. m., to Oakmont Country Club, where members may spend the afternoon playing golf or enjoying each other's society.

Informal dinner at 6.30 p. m.

Meeting of Publication Committee and Board of Directors, 8.00 p. m.

Ladies are invited to participate in this trip. This will be in charge of Messrs. Hitchcock and Rodman.

Thursday, Oct. 4.

Reading and discussion of papers—headquarters, Wm. Penn Hotel, until 1 o'clock.

Complimentary luncheon.

Optional excursions during the afternoon:

1. American Zinc & Chemical Company, Langeloth, Pa. (Zinc Reduction and Sulphuric Acid.)
2. Visit to the new Research Laboratory of the Youngstown Sheet & Tube Company, Youngstown, Ohio. (This laboratory is one of the best things of its kind, having been recently finished at a cost of over $500,000.)
3. Visit to Research Laboratory of the American Sheet & Tin Plate Company, Pittsburgh, Pa.
4. Optional visits to—
   University of Pittsburgh,
   Carnegie Technical Schools,
   Carnegie Museum,
   Bureau of Mines Building (new),
   Mellon Institute of Industrial Research.

8 p. m.—Address by Mr. Alex Dow, President of the Detroit Edison Company, on "Production of Steam from Coal," illustrated by lantern slides and followed by general discussion of the power problem.

This will be of special interest in view of the attention which has been given this subject on account of the shortage of water power at Niagara Falls and the consequent necessity of certain electrochemical industries in the East seeking additional sources of power. Mr. Dow is recognized as one of the foremost authorities on this subject.

9.30 p. m.—Informal reception. Music and light refreshments.

Friday, Oct. 5.

9 a. m.—Symposium: Electrochemical War Supplies.

2 p. m.—Optional exursions to:

1. Atlantic Refining Company, Pittsburgh, Pa. (Refining of Crude Oil.)
2. Owen Bottle Works (showing an extremely interesting automatic manufacturing process).
   Note.—A special car will convey members to both these plants. Messrs. Kemery and Goodale in charge.
3. Republic Chemical Company, Neville Island (Detinning of Tin Scrap). (Use of Warner Cells for Manufacture of Chlorine.)
   Note.—A special car will convey members to this plant. Messrs. Turnock and Gibson in charge.
4. Radium Laboratory, East Pittsburgh, Pa.

In addition to the above optional trips arrangements are under way for visiting a number of other plants, including:

The By-Products Coke Ovens.

Chemical Manufacturing Works, etc.

There are a large number of electric furnaces in operation in the neighborhood of Pittsburgh which it will be possible for members to visit.

Friday evening—Informal subscription dinner with a number of special features.

Saturday, Oct. 6.

All-day excursion on special train, with complimentary luncheon. The following works will be visited.

Westinghouse Electric & Manufacturing Company, East Pittsburgh.

National Tube Company, McKeesport.

Large electric furnaces at Carnegie Steel Company, Duquesne, Pa.

American Window Glass Company, Arnold, Pa.

New York Meeting of National Safety Council

The Sixth Annual Safety Congress of the National Safety Council will be held in New York City, Tuesday, Sept. 11, to Friday, Sept. 14, inclusive, with headquarters at the Hotel Astor. In connection with the congress the National Exposition of Safety and Sanitation will be held at the Grand Central Palace during the same week.

A glance through the forty-page program of the congress shows the enormous amount of interesting and important work that is to be taken up during the general sessions and the various sectional meetings. The Chemical Section meets on Wednesday, Sept. 12. The Iron and Steel Section meets on Wednesday, Thursday and Friday. The Paper and Pulp Section meets on Thursday and Friday. The program of the Chemical Section is as follows:

CHEMICAL SECTIONAL MEETING
Wednesday, Sept. 12, 1917
2 to 5 P. M.
Chairman, J. R. de la Torre Bueno
General Chemical Co., 25 Broad Street, New York City
Vice Chairman, I. V. Kepner
Pennsylvania Salt Mfg. Co., Widener Blg., Philadelphia, Pa.
Secretary, R. A. Medina
Independence Bureau, Philadelphia, Pa.

Program

1. Report of Chairman.
2. Report of Secretary.
3. Reports of Committees.
4. Appointment of Nominating Committee.
5. Addresses.
   (1) "Manhood Conservation in Munitions and Chemical Plants in Canada"—Dr. John S. Bates, Imperial Munitions Board of Canada, Montreal, Can.
   (2) "General Dangers from Strong and Mixed Acids, from the Safety Man's Point of View"—Mr. R. G. Griswold, E. I. DuPont De Nemours Co., City Point, Va.
   (3) "The Hazards of Caustic Soda Manufacture and Use"—Mr. E. Fiesinger, Semet-Solvay Co., Syracuse, N. Y.
   (4) "Prevention and Treatment of Cases of Poisoning by Tri-Nitro Toluol and Picric Acid"—Dr. R. W. Chaffee, Staff Physician, Semet-Solvay Co., Syracuse, N. Y.
   (5) "Packing and Plant Handling of Hazardous Chemicals, with Special Reference to Returned Empties"—Mr. N. A. Laury, Supt., Camden and Easton Works, General Chemical Co., Camden, N. J.
6. Report of Nominating Committee and Election of Officers.

N. B.—Twenty minutes will be allowed for each of the addresses and discussions.

This program has been arranged with the end in view of making it practical and applicable to present-day conditions.

Some parts of it may seem commonplace to men who have made a life-long study of the safety problems of the chemical industry. It has been found, however, that many of those present at the meetings are representatives of other industries who are users of heavy chemicals and acids in their processes, and who urgently need some light to help them solve safety problems. At this particular moment, however, there are large numbers of people working in chemical lines owing to the enormous growth of the industry in this country because of the war.

Exhibitors at the Exposition

Following will be found a list of exhibitors complete to date at the Third National Exposition of Chemical Industries, to be held in the Grand Central Palace in New York during the week of September 24. We have already published the tentative general program and in our next issue will have some interesting announcements to make in regard to the motion picture program which alone will be well worth a visit to see. The exhibitors to date follow:

Abbe Engineering Co.
Abbe, Paul O.
Ackerman Co., H. R., Inc.
Ainsworth & Sons, Wm.
Alberene Stone Co.
Amalgamated Dye & Chemical Co.
American Aniline Products, Inc.
American Bitumastic Enamels Co.
American Blaugas Corporation
American Chemical Mfg. Co., Inc.
American Chemical Society—Alabama Section
American Coal & By-Products Coke Co.
American Cyanamid Co.
American La France Fire Engine Co., Inc.
American Metal Co., Ltd.
American Synthetic Dyes, Inc.
American Synthetic Color Co.
American Steel Package Co.
American Transformer Co.
Anaconda Copper Mining Co.
Angel H. Reeve & Co., Inc.
Anti-Hydro Waterproofing Co.
Apex Chemical Co., Inc.
Arkell Safety Bag Co.
Armstrong Cork Co.
Arnold Hoffman & Co.

Badger, E. B., & Sons Co.
Baker, J. T., Chem. Co.
Barber Asphalt Pav. Co., Inc.
Barrett Company, The.
Bausch & Lomb Optical Co.
Beach-Russ Co.
Beckers, Wm., Aniline & Chem. Co.
Benzol Products Co.
Bethlehem Foundry & Mch. Co.
Blakiston's, P., Son & Co.
Bloede Co., Victor G.
Boyer Oil Co.
Brassard Co., Inc., The
Bristol Co., The
Brown Instrument Co., The
Buffalo Fdry. & Machine Co.
Butterworth-Judson Corporation

Calco Chemical Co.
Campbell, John, & Co.
Canadian Chemical Journal
Carborundum Company, The
Carolina, Clinchfield & Ohio Ry.
Carrier Engineering Corp.
Castner Electrolytic Alkali Works
Celite Products Co.
Celluloid-Zapon Co.
Central Dyestuff & Chem. Co.
Central of Georgia Railway
Central Scientific Co.
Chemical Catalog Co.
Chemical Co. of America, Inc.
Chemical Construction Co.
Chemical Engineer, The
Chemical Pump & Valve Co.
Chile Copper Co.
Chile Exploration Co.
Chromos Chemical Co.
Clark's Iron Foundry
Clenzall Machines Co. of America
Condensite Co. of America
Consolidated Color & Chem. Co.
Consolidated Gas, Elec. Light & Power Co.
Contact Process Co.
Coors Chem. Porcelain Co.
Corning Glass Works
Corn Products Ref. Co.
Crandall Pettee Co.
Crane Co.
Crescent Color & Chemical Works, Inc.

Day Co., J. H.
De Laval Separator Co.
Denver Fire Clay Co.
Detroit Chemical Works
Detroit Range Boiler Co.
Devine Co., J. P.
Diamond State Fibre Co.
Dorr Company, The
Dow Chemical Co., The
Downingtown Mfg. Co.
Draeger Oxygene Apparatus Co.
Draper Manufacturing Co., The
DuPont, E. I., de Nemours & Co.
Duriron Castings Co.
Dye Products Chemical Co., Inc.

Edison, Thomas A., Inc.
Eimer & Amend
Electro Bleaching Gas Co.
Electron Chemical Co.
Electrolytic Zinc Co., Inc.
Electrolytic Eng. Corp.
Elmore, G. H.
Elyria Enameled Products Co.
Empire Chemical Co.
Equithern Control Corp.
Everlasting Valve Company

Fleisher & Co., W. L., Inc.
Foote Mineral Co., Inc.
Foundation Co., The
Foxboro Co., The
Franco-Swiss Dyes, Inc.
Freeport Sulphur Co.
Fuller Engineering Co.

Garrigues, Chas. F., Co.
Geisenheimer & Co.
General Bakelite Co.
General Chemical Co.
General Ceramics Co.
General Electric Co.
General Filtration Co., Inc.
Glens Falls Mch. Works
Gordon Engineering Corp.
Goulds Mfg. Co., The
Greiner Emil Co., The
Guernsey Earthenware Co.

Hanovia Chem. & Mfg. Co.
Hardinge-Conical Mill Co.
Harrison Safety Boiler Works
Hayward & Co., S. F.
Hellenic Chem. & Color Co.
Hemingway, Frank, Inc.
Hepworth Co., S. S.
Hercules Eng. Corp.
Herold China & Pottery Co.
Hood, B., Mifflin Brick Co.
Hooker Electrochemical Co.
Hoskins Mfg. Co.
Houston Real Estate & Loan Co.
Huff Electrostatic Sep. Co.
Hunter Dry Kiln Co.
Huyck, F. C., & Sons

Imperial Color Works, Inc.
Imperial Dyewood Co., Inc.
Independent Chemical Co.
Industrial Filtration Corp.
International Equipment Co.
International Glass Co.

Janney Steinmetz & Co.
Jewell Polar Co.

Kalbfleisch Corp., The
Kelly Filter Press Co.
Kewaunee Mfg. Co.
Keystone Fibre Products Co., Inc
Keystone Minerals Co.
King Chemical Co.
Klett Mfg. Co., Inc.
Klipstein, A., & Co.
Knoxville Board of Commerce
Koppers Co., H.

Laboratory Supply Co., The
Lead Lined Iron Pipe Co.
Leeds & Northrup Co.
Lehigh Car Wheel & Axle Works
Lehigh Foundry Co., The
Lehigh Stoker Co., The
Life Saving Devices Co.
Little, Arthur D., Inc.
Lummus, Walter E., Co., The
Lungwitz, Emil E.
Lunkenheimer Co., The
Luzerne Rubber Co.

Macbeth-Evans Glass Co
Machinery Utilities Co.
Madero Bros., Inc.
Manufacturers Record
Marden, Orth & Hastings Co., Inc.
Martien & Co., Wm.
Matthieson Alkali Works
Merck & Co.
Metallurgical & Chemical Engineering
Metz, H. A., Laboratories
Metals Disintegrating Co., Inc.
Mine & Smelter Supply Co.
Monarch Mfg. Works
Monsanto Chemical Works
Moore & Simonson
Mott, J. L., Iron Works
Moulton Engineering Corp.
Multi-Metal Sep. Screen Co.

Nash Engineering Co.
Nashville, Chattanooga & St. Louis Ry.
National Aniline & Chem. Co.
National Gum & Mica Co.
New Process Chem. Co.
Newport Chemical Works, Inc.
New York Revolving Portable Elevator Co

Niagara Alkali Works
Nitrogen Products Co.
Norfolk & Western Ry.
Norton Company

Obex Company, The
Ohio Pottery Co.
Oliver Continuous Filter Co.

Palo Company, The
Paper, Inc.
Paper Mill & Wood Pulp, News, The
Pennsylvania Salt Mfg. Co.
Pfaudler Co., The
Philadelphia Quartz Co.
Pneumercator Co., Inc.
Pratt Eng. & Machine Co.
Precision Instrument Co.
Precision Thermometer & Inst. Co.
Process Engineers, Ltd.
Product Sales Co., The
Prest-O-Lite Co., Inc.
Provost Engineering Corp.
Pyrolectric Instrument Co.

Quigley Furnace Spec. Co.

Radcliffe Color & Chemical Works
Raritan Copper Works
Raymond Bros. Impact Pulverizer Co.
Research Corporation
Research Laboratory of Chicago
Roessler & Hasslacher Chem. Co.
Ruggles-Coles Engineering Co.

Schaar & Co.
Schaeffer & Budenberg Mfg. Co.
Schaum & Uhlinger, Inc.
Schutte & Koerting Co.
Scientific Equipment Co.
Scott & Co., Ernest
Semet-Solvay Co.
Seydel Mfg. Co., The
Sharples Specialty Co., The
Shriver & Co., T.
Sidio Co. of America, The
Solvay Process Co.
Southern Railway System
Sowers Mfg. Co.
Sparks, John C.
Squibb, E. R., & Sons
St. George Chemical Co.
St. Lawrence Talc Co.
Stamford Mfg. Co., The
Standard Aniline Products, Inc.
Standard Emarex Co.
Stevens-Aylesworth Co.
Stokes, F. J., Mch. Co.
Sturtevant Mill Co.
Sweetland Filter Press Co.
Swenson Evaporator Co.

Tank Equipment Co.
Takamine Laboratory, Inc.
Taylor Instrument Companies
Tenn. Coal, Iron & Railroad Co.
Texas Co., The
Textileather Co.
Textile Colorist
Textile World Journal
Thermal Syndicate, Ltd., The
Thwing Instrument Co.
Toch Bros.
Tolhurst Machine Works
Trade News Service

Uehling Instrument Co.
United Filters Corp.
United Gas Improvement Co.
United Lead Co.
United States Cast Iron Pipe & Fdry Co.
United States Magnesite Corp.
United States Smelting Co., Inc.

Van Dyk Co.
Virginia Smelting Co.

Wallace & Tiernan Co., Inc.
Warner Chemical Co.
Warner Klipstein Chem. Co.
Warren Webster & Co.
Werner & Pfleiderer Co.
West Texas Mica Co.
Westinghouse Elec. & Mfg. Co.
Whitall Tatum Co.
Williamsburg Chemical Co., Inc.

Zapon Leather Cloth Co.
Zaremba Company

Annual Meeting of Society of Chemical Industry

The annual meeting of the Society of Chemical Industry was held at Birmingham, England, at the University, during the week of July 16, 1917. Dr. Charles Carpenter presided and about 200 were present. The Council forwarded to the Board of Trade the following resolution:

In view of the impossibility of deriving benefits from patents during the war, the Council of Safety of Chemical Industry is of opinion that the payment of the annual fees upon patents should be suspended during the war, and that the duration of British patents should be extended for the same period.

The president in his address made a special plea for a greater education of the people in chemistry and engineering.

Special subjects which are being taken up by committees of the society are, refractories, industrial alcohol, and sugar. The following list of papers which were read show the trend of applied chemistry in England at the present time:

Some Observations on the Texture of Fire Clays. By W. E. King.

Chemical Porcelain. By Henry Watkins.

Sands Used in Metallurgical Practice and in Glass Manufacture. By P. G. H. Boswell.

Industrial Fuel from Gasworks. By E. W. Smith.

The Calorific Value of Industrial Gaseous Fuel. By W. J. Pickering.

Some Sources of Benzene and Toluene for High Explosives. By T. F. E. Rhead.

The Synthesis of Ammonia and its Oxidation to Nitric Acid. By E. B. Maxted.

Manufacture of Synthetic Nitrates by Electric Power. By E. Kilburn Scott.

Gasoline Specifications for Government Use

The method adopted by the Bureau of Mines in preparing specifications for Federal purchases of gasoline in the District of Columbia was briefly described in the *Engineering News-Record*, as follows:

Samples of the various types of motor gasoline sold in the district were analyzed. A specification was then written which represented the average product already on the market, previous experience having indicated this to be satisfactory. The procedure adopted made it possible for the Federal Departments to obtain motor fuel suitable for the motors in use, and equal in quality to that dispensed to private users. While this method of determining specifications is not absolutely scientific, it is practical and gave the following specifications:

COLOR

Requirement—Water white.

Method of Determination—Inspection of column in 4-oz. samples bottles.

ACIDITY

Requirement—Total absence.

Method of Determination—Ten cubic centimeters of the gasoline is to be shaken thoroughly with 5 c.c. of distilled water. The aqueous extract must not color blue litmus paper pink.

VOLATILITY

Requirement—The gasoline shall, when distilled by the method described in Technical Paper No. 166 of the Bureau of Mines, meet the following requirements:

A. The temperature read on the thermometer when 20 per cent has distilled shall not be below 70 deg. C. (158 deg. Fahr.), nor above whatever limit is fixed after due consideration of conditions of use.

B. The temperature read when 90 per cent has distilled shall not be above another limit similarly chosen.

C. The temperature read when 50 per cent has distilled shall not be higher than a mark halfway between the 20 per cent and the 90 per cent limit.

D. The dry point shall not exceed the actual 90 per cent reading by more than 55 deg. C. (99 deg. Fahr.).

Tolerance—If either the 20 per cent or the 90 per cent temperature mark is above the required limit by an amount not exceeding 10 deg. C. (18 deg. Fahr.), the gasoline may be considered acceptable if the sum of the two temperatures read for the 20 per cent and the 90 per cent marks does not exceed the adopted limit.

Output of American Dyestuff Industry

In an attempt to secure more complete and detailed returns of the dye industry in the United States on June 6, the Bureau of Foreign and Domestic Commerce sent out return blanks to all manufacturers of dyestuffs known to the bureau, and the returns just compiled are from practically all. More than 100 forms were returned, and the data includes the entire industry with the exception of a few minor firms and of new business organizations about to enter upon manufacturing.

From figures submitted by the manufacturers the following totals of monthly production for the current year have been compiled:

	Firms Making Returns	Pounds
Crudes	22	.....
Benzol, toluol and some xylol and phenol (Gals.)	..	1,240,350
Benzol, toluol, natural and synthetic phenol, cresol, naphthalene, anthracene and some xylol, cumol and amylene	..	6,181,600
Intermediates	40	10,420,600
Artificial colors	46	5,000,000
Vegetable dyestuffs and extracts (including some tanning extracts not stated separately)	13	8,183,500

These returns are nearly complete. They are fairly representative of the industry as a whole, though faulty from a statistical standpoint since no returns were received from several minor firms so recently established as to be unable or unwilling to go into details of product and output, but whose combined production for the remainder of the calendar year would constitute only a small percentage of the whole. In some instances the figures for benzol are in excess of the amount used in the production of synthetic phenol.

Manufacturers are now producing toluidines, resorcin, xylidine, dianisidine, naphthylamine, diphenylamine, tolidine, benzidine, benzaldehyde, benzylchloride, nitrobenzol, nitrotoluol, H-acid, phthalic, metanilic, sulfanilic and naphthionic acids, naphtholsulfo acids, naphthylaminsulfo acids and amidonaphtholsulfo acids, Schaeffer's salt, paranitraniline, dimethylaniline and others.

The current monthly production of forty-six manufacturers of finished dyes is at the rate of 5,000,000 lb., or 60,000,000 lb. annually, individual outputs ranging from 600 to over 2,000,000 lb. each. This does not include any estimate from one plant of the first magnitude whose entrance into the industry has just been announced to the trade, or a score of smaller projects organized but not yet in full operation. The total shown includes only the figures given by the factories of actual

production for the current calendar year, and makes no allowance for many plants now in course of construction, which will soon be producing colors on a commercial scale, nor for the output of many dyes still in the experimental stage. These facts leave no doubt that our present annual domestic output greatly exceeds in quantity the entire consumption of artificial colors in the United States during the year 1914, estimated at 60,000,000 lb., and is probably equivalent to the current annual consumption, which is considerably in excess of that for 1914.

Coal-tar dyes in a variety of colors suitable for leather, textiles, straw, paper, inks, stains, pigments, varnishes, waxes, feathers, furs, and for many other purposes are now regularly obtainable from domestic sources. Several manufacturers carry full lines of direct, acid, basic, chrome, oil and sulphur colors, while others confine their efforts to improving and extending their output of particular groups. Prominent among the colors produced are nigrosines, indulines, triphenylmethane dyes, safranines, eosines, chrysoidines, thodamines, rosanilines, direct fast reds, browns and yellows for cotton, fast chrome colors for wool, Sudan colors, basic violets, synthetic indigo and indigotines, alkali blues for the silk and woolen industries and also for the lithographic trade, metanil yellow, methyl violet, methylene blue, benzopurpurine, benzo sky blue, primuline, naphthol green, rose bengale, gallocyanine, and special chrome and khaki colors.

Considerable attention is being given by about a dozen firms to developing as rapidly as the requisite intermediates are available the triphenyl-methane dyes, particularly fuchsine, methyl violet, methylene blue, magenta, and malachite green. Their output of many of these colors was not separately stated by some of the factories. The itemized figures given by only a few of the plants, however, show a monthly production of this series of colors amounting to 62,200 lb. Of this quantity 18,200 lb. represent methyl violet and 13,450 lb. methylene blue. Two manufacturers specialize on the needed intermediates for these dyes.

There is a largely increased production and variety of reds, yellows, and scarlets, prominent among them being parareds for the printing trade, lithol red R, paramagenta, croceines, fast red Bordeaux for wool, acid reds and scarlets, wool scarlet, Biebrich scarlet, chrome yellow, metanil yellow, chrome orange, and brilliant orange. A wide range of fast reds, blues, greens, yellows, blacks, and grays for cotton is also available.

Colors now produced on a commercial scale that were not made in this country until recently are alizarin blues, browns, and yellows for calico printing, and for wool; paracolors for lakes or pigments, vat dyes (sometimes called indigoids) for cotton shirtings and ginghams, synthetic indigo, rhodamine, patent blue, and Biebrich scarlet.

Present production and new developments contemplated include blacks and greens in natural colors for calico printers, a special logwood blue, special mordants for dyeing new shades in direct cotton colors, khaki dyes, cutch, archil, and logwood extracts, and cudbear powdered, orange, and lemon flavines, Osage orange in a variety of shades, American sumac extract, indigotin, and natural indigo shades. It is stated by several plants that their output depends on the domestic demand, ample facilities being available for a largely increased production at any time. Some operate at half capacity while others are running 24 hours a day.

One firm is making sulphur brown (not a coal-tar product) on an extensive scale, while another company is producing mineral colors in standard shades for wool.

Soluble Prussian blue, Chinese blue, pigment brown, lakes in all the principal colors, paratoners, dry colors, and dyes for lake makers are specialties handled by different manufacturers.

The urgent demand for photographic developers since the war began has greatly stimulated the production of hydroquinone, p.-amido-phenol, metol, amidol, and reducin. Single firms report monthly outputs of 1000 to 15,000 lb. each of hydroquinone.

Manufacturers of coal-tar by-products are also marketing quantities of salicylic acid and its derivatives—particularly acetyl-salicylic acid (aspirin)—phenacetine, acetphenetidin, acetanilide, and other medicinals.

One maker of intermediates is producing the synthetic perfumes nerolin and bromelia. Another firm includes vanillin, used in flavoring extracts, in its list of products, and also saccharin.

The most striking feature brought out on the forms filled in by the dyestuff manufacturers is the marvelous growth of the industry and the plans in process of formation for its continued expansion in both domestic and foreign fields.

Announcement has been received of the entrance into the dyestuff industry of the leading company manufacturing explosives, fully equipped with a chemical and engineering staff, plant, and laboratory facilities, and an adequate commercial organization to meet the demand for colors on a vast scale. Other new plants in process of construction or to begin operations before 1918 are two for coal-tar crudes, one for anthracene, one for glacial acetic acid, four new buildings for aniline dyes, one for chrysoidine and methylene blue, one for nigrosine, induline and magenta, and one for nigrosine only. A producer of direct, acid, and chrome colors expects to double his present output of nearly half a million pounds annually inside of 12 months. One plant making methylene dyes is planning to double its capacity, two others making aniline colors will also double their capacity shortly, one manufacturer expected to have patent blue and fuchsine on the market after July, one of the larger corporations is now making auramine and lanafuchsine on a small scale and installing equipment for their increased output, and another contemplates the manufacture of primuline in considerable quantity. A producer of high-grade colors for silk is enlarging his factory and contemplates the early production of safranine and a suitable plant for the extensive manufacture of aniline dyes.

Dyes and dyestuffs exported from the United States during the fiscal year ending June 30, 1917, were valued at $11,710,887, as compared with $5,102,002 for 1916. Beginning with July 1, 1917, the classification for monthly statements of exports will include under dyes and dyestuffs the subdivisions, aniline dyes, logwood extract and all other shown separately.

The capital stock of the ninety companies reporting amounts to a total of $158,913,650. This, of course, does not represent actual money invested, as many concerns merely incorporate with a large capital to allow for expansion. The actual amount of paid in capital and capital invested in plants is not known.

The Electrolysis of Fused Cerium Chloride[1]

By M. deKay Thompson

That cerium can be produced by the electrolysis of fused cerium chloride is a well known fact, and it is also known that this is the method of manufacturing the cerium imported into this country before the outbreak of the war. That the process is workable is therefore well established, but to carry it out on a commercial scale with simple apparatus requires the knowledge of a number of details which have never been published. It was the object of the following work to find the proper conditions for the manufacture of cerium and to produce enough to demonstrate that this end had been reached.

The nearest approach to what was desired is the work of Hirsh.[2] A review of previous investigations on this subject is given in this article, and may therefore be omitted here. Hirsh made in all only about 1.5 kilograms of metal, and had to dehydrate his cerium chloride in an atmosphere of hydrochloric acid to prevent decomposition, and even then the baths tended to become pasty after a few hours electrolysis. Certainly no one would consider these results a sufficient preparation for starting upon the manufacture of cerium.

There are a number of difficulties that may be encountered in attempting to electrolyze fused salts. The principal ones are the following:

1. The anode effect[3] which has the appearance of being a sudden insulation of the anode from the melted bath by a film of gas. This prevents the current from passing unless a high voltage is applied, and when this is done a high temperature is produced, with consequent vaporization of the salt. One method of overcoming this is to design the apparatus so as to have a lower current density at the anodes.

2. The bath becomes viscous, and will not conduct properly. This was the cause of much trouble to Hall while he was working out the process for aluminium.

3. The metal does not collect in a solid nugget, but remains distributed through the salt in small particles.

4. The metal dissolves in the fused bath, diffuses to the anode and recombines, as in the case of sodium or potassium hydrate.

5. The salt decomposes during dehydration or during electrolysis. This is especially apt to occur with chlorides.

In the following work no trouble was experienced with the anode effect; it appeared only once or twice during the whole course of the experimentation. The principal difficulty was that on electrolysis the salt turned into a black mass, which on cooling smelt like carbide, and which showed no sign of metal to the naked eye. This may be formed even when the electrolysis is to all appearances proceeding properly. Some decomposition took place during dehydration, but this was easily rectified during the electrolysis, as will be explained.

The first raw material was obtained in the form of the hydrated cerium chloride, somewhat of the appearance of brown sugar. Later, over 300 lb. of cerium oxide were obtained from the Welsbach company, which was converted to the chloride by dissolving in strong hydrochloric acid in earthenware crocks and evaporating to dryness in enamel lined preserving kettles. It was then broken out of the kettle with a cold chisel and kept in air-tight jars. The dehydrated cake was about 1.5 cm. thick; if thicker than this, there was difficulty in dehydrating the top without burning the bottom of the kettle.

The following data were obtained: 35 kg. of cerium oxide and 102 kg. of strong hydrochloric acid made 45.4 kg. of anhydrous cerium chloride, from which 22.7 kg. of metal can be made. The metal was of course impure cerium, containing other rare earth metals.

The method employed for the estimation of cerium was to precipitate the cerium by alkali hydrate, filter, wash free from chloride, dissolve in sulfuric acid, and reduce to cerous sulfate with hydrogen peroxide. Permanganate was then added till the excess of peroxide was destroyed, as shown by the end point. The cerous sulfate was then oxidized with an excess of potassium ferri-cyanide and the ferro-cyanide produced was titrated with permanganate.[4]

The first supply of cerium chloride was found to be 52 per cent pure. A 10-lb. sample of cerium oxide obtained at an earlier date from the Wellsbach company, and which could be put into solution only by first converting it into the carbide[5], grinding very fine, and dissolving in hydrochloric acid, was 64.5 per cent pure.

The source of electricity was a 25-kw. direct-current motor generator, in which the voltage could be varied continuously from 10 to 35 volts.

From some of the writer's previous work on cerium chloride electrolysis, and from the description of the difficulties of others, it was believed that one cause of the bath becoming pasty was the formation of carbide by the action of the fused bath on the graphite anode. An attempt was therefore made to use a magnetite anode. The magnetite was fused in a graphite tube by forming an arc between the bottom of the tube and a smaller carbon rod which projected into the tube, and feeding in crushed magnetite. As the magnetite fused, the rod was gradually drawn out. A porous clay pot was used of 7 cm. inside diameter and 7.6 cm. high. An iron rod 0.9 cm. in diameter was used as cathode and was insulated from the fused bath by a porcelain tube, except at the end, which was bent at right angles to bring it under the anode. The electrolysis lasted for three hours at 60 amp. and 13 volts. Red fumes were given off, showing that chlorine displaced oxygen from magnetite with the formation of ferric chloride. Very little metal was found, and the fused salt had turned into the black substance described above having a characteristic carbide smell, and which reacts with water, which cerium carbide does not. This experiment therefore showed that the carbon anode is not the cause of the fused bath becoming pasty. If this black material is held up to a rapidly rotating emery wheel it gives off sparks like metallic cerium, and very small bright surfaces are visible. It therefore seems probable that this black material is cerium chloride with very finely divided cerium distributed through it.

A number of runs were then made in Denver clay crucibles 20 cm. high, and with a cathode made of an iron bolt inserted through the bottom and made tight

[1]This research was carried out from January to June, 1916, in association with Professor C. L. Norton, who proposed the method of dehydrating the cerium chloride employed, and at whose suggestion the experiments in Denver clay crucibles were made.
[2]Trans. Am. Electroch. Soc. 20, 1, (1911).
[3]Met. and Chem. Eng., 7, 19, (1909).
[4]Browning and Palmer, Am. Journ. of Science, 26 (1908), 83.
[5]Muthmann, Hofer, and Weiss, Liebig's Ann., 320 (1902), 261

with iron washers. Information had been received that this was the method used abroad. Some metal was produced, but the results were still not satisfactory. On one occasion the pot bumped violently, as though boiling. One important fact was first observed in these experiments, that the oxide produced by the dehydration of the chloride is regenerated into chloride by the chlorine evolved by the electrolysis. On first melting the anhydrous chloride and electrolyzing, the surface was covered with a scum, but after a few hours electrolysis the whole electrolyte became clear. Also pieces of the broken chloride which were dark brown on the surface exposed to the air during cooling, turned white when placed in the electrolyzing vessel so as to be exposed to the chlorine gas. This change in color is doubtless due to the change from oxide to chloride. During the electrolysis, after the electrolyte had gotten into good condition, the surface of the clear liquid was covered with fine bubbles of the liberated chlorine, which were prevented from escaping immediately on account of the viscosity of the fused salt.

The first satisfactory run in which a compact nugget of metal was produced was carried out in a cast iron crucible 7.5 cm. deep and 6.8 cm. inside diameter. This crucible formed the cathode. The chloride was made from the oxide by dissolving in hydrochloric acid and dehydrating in hydrochloric acid gas, though this method of dehydrating was not necessary, as later experiments showed. The anode was a graphite rod 2 cm. in diameter. Contact with the iron crucible cathode was made by imbedding it in crushed gas-carbon contained in a larger iron pot to which a cable was connected. A current of 90 amp. at 14 volts was passed until the number of ampere hours was 882. The material was 32 per cent pure. A nugget weighing 310 grams was obtained at a current efficiency of 21 per cent. In this experiment the right combination of current, voltage, and distance between electrodes had been found to cause a large amount of the deposited cerium to fuse together. This is doubtless due to the temperature being within certain limits: high enough to melt the cerium and low enough to prevent the formation of the black material. Whether or not this is the true explanation of the success, the proper conditions for the production of cerium were found and the next step was to try to get the same conditions on a larger scale.

For this purpose a cylindrical cast iron pot, 22 cm. in diameter and of about the same depth was taken as cathode. Contact was made as in the case of the preceding run with the smaller crucible. The anode was a graphite rod 5 cm. in diameter. The chloride in all following experiments was made from oxide and was dehydrated in kettles as stated above, either with gas or electric hot plates. The experiment was started at 1.45 with 400 amp. and 13 volts. The chloride was fed in until it was within 4 cm. of the top of the pot, and at 3 p. m. the current was increased to 600 amp. At 3.20 the bath showed signs of becoming viscous. The whole bath had turned black and the escaping gas blew large bubbles of this black substance which solidified in thin crusts. The evident explanation of this was that the temperature was too high. At 3.30 the anode was lowered so as to make contact with the cathode when cold and the current was shut off. The following day a current of 300 amp. at 11 to 13 volts was passed from 11.15 to 4.30. By this time the bath had regenerated itself and was in good working order. The third day the electrolysis was continued with 300 amp. from 11.30 to 5.30 and the fourth day from 10.45 to 6.30. The yield was 3.03 kg. of metal in one large nugget and two smaller ones. The total ampere hours were 5800, and the current efficiency 30 per cent. About 1300 ampere hours were used inefficiently on account of the bath getting into bad condition by overheating. If this is not counted it brings up the current efficiency to 40 per cent.

A longer test was next made. The same size iron pot was used, and a 5-cm. graphite anode. The run was started 11.30 A. M., April 21, and lasted till 5.45 P. M. of the following day, without interruption. The current was about 300 amp. at 10 to 12 volts. The anode was kept about 1.7 cm. from the cathode, and the fused chloride was about 3.2 cm. deep. As the metal built up from below more solid chloride was added and the anode was gradually withdrawn until the pot was full. The run was started by melting some chloride in a Dixon graphite crucible and pouring it into the pre-heated iron pot. The anode was also pre-heated. The results were:

Chloride fed into pot	6.37 Kg
Metal obtained	3. Kg
Ampere hours	8700.
Current efficiency	20 per cent

A run was next made under the same conditions as in that just described except that the electrodes were brought so close together that only 5 to 6 volts were required to pass 300 amp. The smell of hydrochloric acid was strong during this run. Practically no metal was produced, but in its place appeared the black material described above. This experiment showed the electrodes must be kept a certain distance apart.

A run was then made with two pots connected in parallel, which lasted continuously from 11 a. m., May 26 to 11 a. m., May 27. The average current was 230 amp. per pot. The following table gives the results:

	No. 1	No. 2
Ampere hours	5500	4530
Kilograms of metal	2.37	1.87
Current efficiency	25 per cent	24 per cent

It may also be interesting to give the record of this experiment in full, showing the small amount of attention required. This is shown in table No. 1 on the next page.

In the next experiment four 5-cm. graphite anodes were used and the cathode was a cylindrical iron pot 20.5 cm. in diameter. Contact was made at the flanged top by means of two iron strips bolted to the flange on opposite sides of the pot. Some chloride was melted in the pot by a gas burner, and when the pre-heated anodes were immersed the electrolysis started immediately. The run lasted 5.25 hours with an average of 710 amp. and 8.5 volts, and produced 960 grams of metal at a current efficiency of 14.5 per cent.

In the next runs iron plumbers' pots, used for melting lead, were used. These were 21.5 cm. in diameter at the top and somewhat smaller at the bottom. Contact was made by bolting an iron strip to the bottom of the pot by a bolt put through a hole in the bottom. Four 5-cm. anodes were used. The current varied from 600 to 800 amp. at about 9 volts and the run lasted for six days, allowing it to cool over night. The electrolysis was started in the morning by heating the pot with a large blast lamp. The results were:

Ampere hours	15,200
Theoretical yield	23.8 Kg.
Actual yield	7.8 Kg.
Current efficiency	30 per cent

Another similar run on two successive days gave 1.03 kg. metal at 20 per cent current efficiency.

Finally a run with two pots with four 5-cm. anodes each lasted from 11 a. m. to 7.45 p. m. and from 9.30 a. m. to 9.10 p. m. of the following day. The current through each pot was about 500 amp. at 10 volts. The results were:

	No. 1	No. 2
Metal obtained	4.75	5.48
Ampere hours	8940	10,000
Current efficiency	30 per cent	31 per cent
Chloride fed in	21.3 Kg.	23.9 Kg.
Cloride left undecomposed	11.5 Kg.	15.2 Kg.
Kilowatt hours	94.1	105
Kilowatt hrs. per Kg metal	19.8	19.2

During the course of these experiments 34 kg. (75 lb.) of metal were produced, and after finding the proper conditions as regards current, volts, and distance between anode and cathode, the electrolysis always proceeded without any difficulty. The directions for carrying out the electrolysis are:

The electrolysis is best started by melting a little chloride in the iron electrolyzing vessel or in a Dixon graphite crucible from which it is poured into the electrolyzing vessel. The anodes should be hot to prevent the salt from freezing around them and insulating the current, when first immersed. The fused chloride should be about 2.5 cm. deep, and the anode should dip into it 1.7 cm. The voltage between anode and cathode should be about 10, and the current for a pot with one 5-cm. anode will then be between 250 and 300 amp. If more anodes are grouped together, the current carried by each should be somewhat less. The pots should not be heat-insulated. As the metal builds up, the anode is raised and chloride is added, either in solid lumps or fused; it interferes less with the electrolysis to add fused chloride. The cerium could be poured directly from the electrolyzing vessel, but in these experiments it was allowed to cool, the pot was broken open, and the metal separated from the chloride. This was remelted under sodium chloride and cast into bars in Acheson graphite molds.

The metal is always surrounded with the black material described above. This can be recovered for another electrolysis by dissolving in hydrochloric acid and evaporating to dryness.

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Cambridge, Mass.

TABLE I—LOG OF EXPERIMENT ON CERIUM CHLORIDE

No. 1				No. 2			
Time	Amp	Volt	Remarks	Time	Amp.	Volt	Remarks
A.M.				P.M.			
11	140	10.9	Started.	1.00	220	10.3	Started.
11.30	200	8.9	More chloride added	2.20	230	9.8	Chloride added. Viscous.
P.M.							
12.30	160	11.2	Still viscous.	5.10			Chloride added.
12.45	160	11.3	Chlorine smell beginning to be strong.	5.50	200	10.2	
				7.50	240	10.3	In fine condition Dull red on outside.
1.15	160	11	In fine condition.				
2.20	250	10		8.50	300	9.6	Chloride added.
3.08			Bright red outside. Carbon surrounding pot removed.	10.00	190	11.9	
				11.45	240	11.4	
				A.M.			
4.35	250	10.2		12.45	230	10.5	
5.10			Chloride added.	1.40	240	10.3	
7.50	250	10.1		2.10			Pot nearly entirely covered by condensed vapor of chloride.
8.30			Chloride added.				
8.50	270	11.2					
9.50	200	12.7					
11.45	240	12.9	Voltage lowered.	4.50			Chloride added.
A.M.				5.50	200	10	Chloride added.
12.45	220	11.5		6.00	240	0	
2.30	260	11.1		6.30			Rounded end of anode sawed off.
7.25	230	10.7	Chloride added.				
9.40	320	10.9	Chloride added. Anode eaten to a point, and therefore sawed off.	6.45			Chloride added.
				8.45			Pot full. Shut down.
11			Pot full; shut down.				

Sulphuric Acid from Blende*

By H. M. Ridge

SOURCE OF ZINC SULPHIDES

Spelter was formerly made only from calamine, which is the carbonate of zinc, but as the world's supply of this mineral is limited it became necessary, particularly about the middle of the last century, to use zinc sulphide ore, the demand for which increased very rapidly.

The main source of spelter to-day is zinc blende. When pure this consists of zinc sulphide with 67 per cent zinc and 33 per cent sulphur and is a white, transparent mineral. The pure mineral is rarely found; zinc blende is generally black or brown and contains several per cent of iron as amorphous FeS, and frequently also some manganese. In consequence of impurities, the sulphur content is usually less than the above-mentioned figure, but if pyrites, FeS_2, is present, the sulphur assay rises.

In the ore deposits zinc blende is usually associated with galena and occasionally with copper pyrites, but it is found with most sulphide ores. No particular kind of gangue predominates; in addition to quartz, calcite, strontianite, magnesite, ankerite, siderite, barytes, and fluorspar are frequently present. Quartz and calcite are lighter than blende, barytes is heavier; the differences in specific gravity are sufficient to allow of separation by ordinary wet methods of concentration. If fluorspar is present wet concentration should be carried out carefully because it is desirable to remove fluorine, as far as possible. Siderite and ankerite have been taken out efficiently on the Continent on magnetic separators after a preliminary flash roast to form magnetic iron oxide (Fe_3O_4).

The utilization of the zinc contents of the big deposit of argentiferous zinc and lead ore at Broken Hill presented unusual difficulty, because of the presence of garnet and rhodonite of about the same specific gravity as zinc blende. This was first overcome by the use of the Wetherill electromagnetic separator with an intensely strong magnetic field. When I started the first of these plants at Broken Hill in 1899, we lifted the garnet and rhodonite out of the ore with one set of machines and then passed the residue through an even stronger field which separated the zinc blende from the galena, quartz, and calcite. This process was too expensive to be able to compete permanently and was superseded by the modern methods of flotation; to-day the whole of the zinc concentrates at Broken Hill are produced by flotation. Unfortunately, flotation methods are not, up till now, effective for separating fluorspar or carbonates from blende.

The rapidly increasing consumption of spelter threatened to cause a shortage of ore as long as calamine was the main source of supply, but improved methods of

*A paper read before the London Section, Society of Chemical Industry, June 4, 1917.

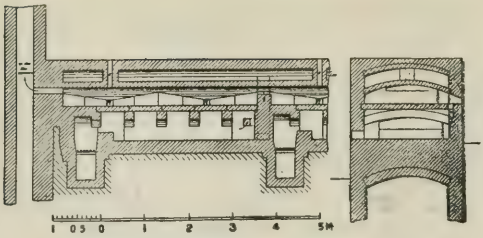


FIG. 1—HASENCLEVER FURNACE

concentration and of smelting have resulted in making available enormous resources of sulphide ore and there is an adequate supply of suitable concentrates to cope easily with all prospective demands.

I propose, in dealing with the utilization of the sulphur contents of zinc ore, to divide the subject into:

1. The extraction of the sulphur from the mineral.
2. The utilization of the sulphur.
3. Statistics and economics.

GENERAL STATEMENT OF SULPHIDE TREATMENT

The sulphur can be separated from the zinc by:

(a) Smelting with a metal having greater affinity for sulphur.

(b) Treatment with the oxide of a strong base.

(c) Heating in the presence of oxygen.

Zinc sulphide is decomposed by molten metallic iron or copper and a sulphide is formed, while metallic zinc vapor is driven off. Considerable experimental work has been done on this process, but without success, because of the expense of treating the resulting iron or copper sulphide and the possibility—when copper is used—of losing some of this metal in the process. The operation has to be carried out in a retort or crucible at a high temperature. This has some similarity to the ancient methods of brass manufacture by smelting copper ore and zinc carbonate together with carbon.

Zinc blende can be smelted with lime and carbon to form zinc, carbon monoxide, and calcium sulphide; this has been carried out in an electric furnace, but it entails a continuous fresh supply of lime, while the resulting impure sulphide of lime quickly oxidizes to sulphate and has to be run to waste.

The usual method of separating the sulphur from blende is to roast the ore with sufficient air to form zinc oxide and sulphur dioxide. The further treatment of the zinc concentrates after roasting consists in heating the zinc oxide in retorts, with suitable reduction material, to reduce the oxide and distill the reduced metallic zinc which is cooled and condensed to liquid metal.

THERMAL CONSIDERATIONS

In roasting zinc blende the sulphur is oxidized to SO_2 with a small amount of SO_3, and sufficient oxygen is also required for the formation of zinc oxide. The reaction is exothermic, but it is not possible to obtain a sweet roast without the application of heat. Sulphates are formed in roasting and these have to be decomposed, which necessitates additional heat units.

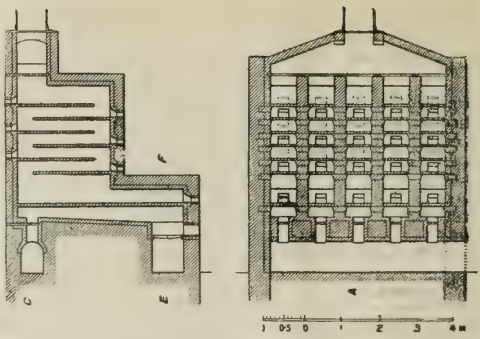


FIG. 2—IMPROVED HASENCLEVER FURNACE BUILT BY THE RHENANIA COMPANY

The heats of formation are:

$$(Zn + S) = 43{,}000$$
$$(Zn + O) = 84{,}800$$
$$(2S + O) = 69{,}260$$

If 97 kg. of zinc sulphide is oxidized completely with air containing 48 kg. of oxygen, 81 kg. of zinc oxide and 64 kg. of sulphur dioxide, equal to 22.4 cu. meters, are obtained; 200 kg. of air with 160 kg. of nitrogen will be used.

The reaction gives:

	Calories.
Formation of 81 kg. ZnS	+ 84,800
Formation of 64 kg. SO_2	+ 69,260
Total	154,060
Decomposition of 97 kg. ZnS	— 43,000
Net heat evolution	111,060

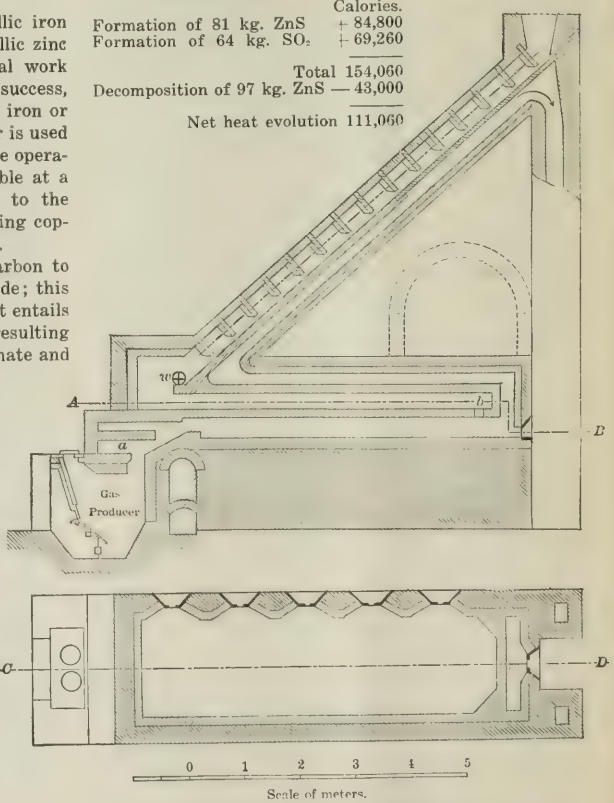


FIG. 3—HASENCLEVER & HELBIG FURNACE

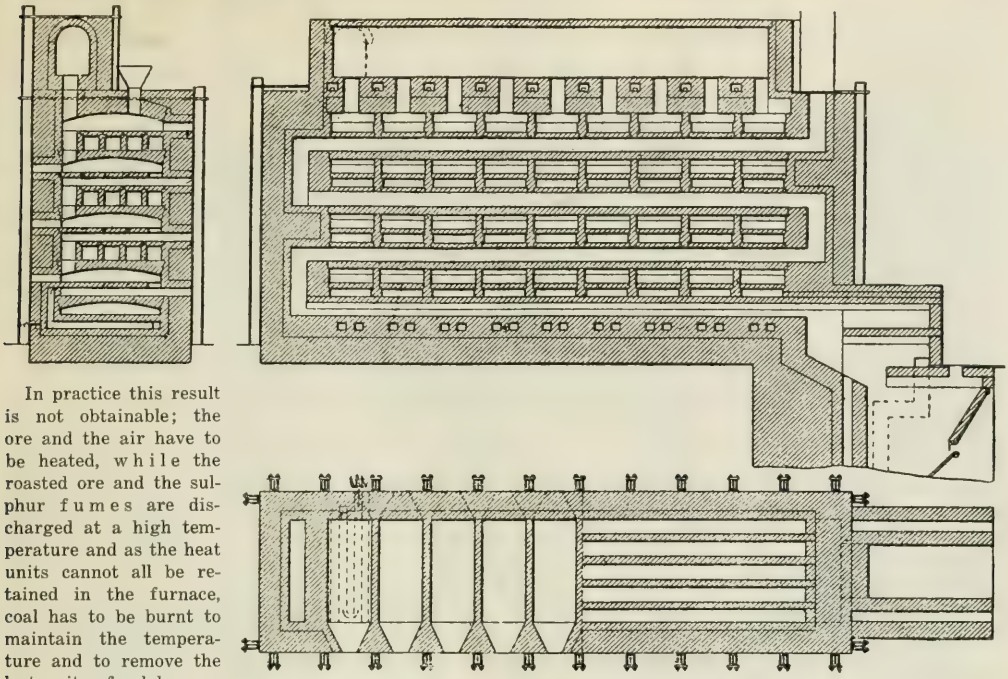


FIG. 4—RHENANIA TYPE FURNACE

In practice this result is not obtainable; the ore and the air have to be heated, while the roasted ore and the sulphur fumes are discharged at a high temperature and as the heat units cannot all be retained in the furnace, coal has to be burnt to maintain the temperature and to remove the last units of sulphur.

If the sulphur has to be used for technical purposes, the fumes must not be contaminated and diluted with fire gases. Constructional difficulties were encountered in the design of furnaces for this purpose. Muffled furnaces have to be used in which the fire gases do not come into contact with the ore, and the heat units have to be passed through firebrick in order to maintain the temperature while the last units of sulphur are being oxidized and while any sulphates which may have been formed are being decomposed.

EARLY ROASTING FURNACES

In Germany and Belgium prolonged efforts were made to prevent the emission of large quantities of sulphur fumes into the air, with the consequent destruction of vegetation in the neighborhood of the works. The first practical results were obtained about 1855 by Hasenclever, who, after a series of experiments, built a furnace at the Rhenania works, which is shown in Fig. 1. The furnace has two roasting hearths, of which only the top hearth is muffled, and after the ore has been rabbled along this hearth and has given off some of its sulphur it is dropped to the bottom hearth to complete the roasting in direct contact with the fire gases. The arches of the furnaces were too high for practical work and the fumes were low in SO_2.

In 1865 a much improved furnace was built by the Rhenania Company, and this is illustrated in Fig. 2. The results improved, but the capacity of the furnace was small and the strength of the gas continued deficient; it is worthy of note that the designer realized that it was only necessary to heat the ore during the last stages of oxidation, because there is enough heat at the commencement of roasting, but this point was overlooked for many years. The general idea of the construction of the furnace is very similar to that of "Delplace," which will be referred to later.

An effort to reduce the amount of labor was made in 1872 with the furnace shown in Fig. 3. A number of these furnaces were built at various works in Germany, but they again labored under the disadvantage that the final roast was carried out in contact with the fire gases. The furnace had 215 sq. ft. of area on the bottom direct-fired hearth, and above this a muffle of the same size was heated from above and below by the fire gases. The incline had an angle of 43 deg., which had been determined by experiment, and baffles were placed in this, so as to spread the ore in a fairly uniform thin layer. Openings were arranged for access in case of blockage. The ore traveled a total distance of about 90 ft. in the furnace. Much labor was required for breaking up lumps of ore which formed, and the furnace had to be very carefully tended. During the period when much sulphur is being given off the ore will run like water if the temperature rises too high, and if iron or lead are present in appreciable quantity the overheated ore will set hard. This frequently occurred on the incline and the design was finally discarded, because more labor was required for freeing the incline than is necessary for working a horizontal hearth. The output of the furnace per 24 hours was about 3 tons of roasted ore with a coal consumption of 15 cwt., and three men were necessary per shift, so that the output per man per shift with a 12-hour shift was only 10 cwt.

In the furnaces which were designed for part of the work to be done in the muffle and the balance in a rever-

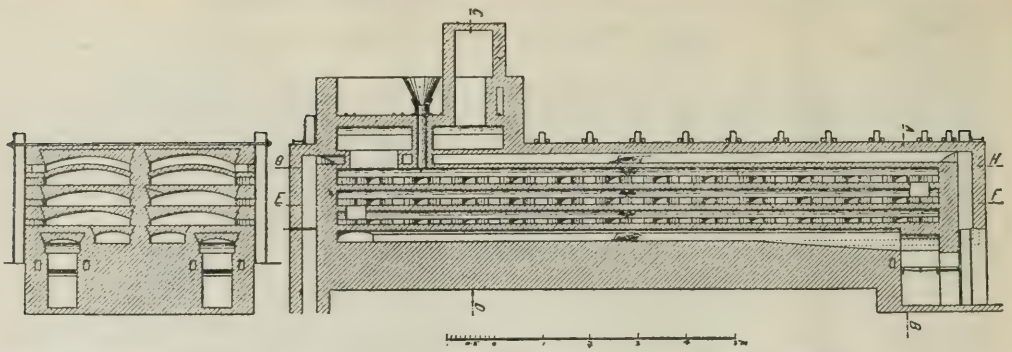
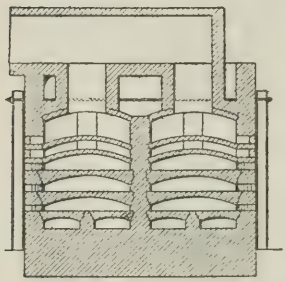


FIG. 5—MODIFIED RHENANIA TYPE FURNACE



beratory, only about two-thirds of the sulphur contents were available for further use, while the remaining one-third was so diluted by the fire gases that it had to be allowed to escape into the atmosphere

In England attempts were also made to roast zinc ore in muffled furnaces, but they were not entirely satisfactory. It is remarkable that the first roasting of blende appears to have been done here. In 1758 John Champion of Bristol obtained a patent for using blende or black jack in the manufacture of brass.

RHENANIA TYPE FURNACES

The first of the furnaces of the so-called Rhenania type is shown in Fig. 4; this was built in accordance with a German patent of 1882. The furnace is provided with one fire box, and the fire gases travel four times the length of the furnace, which has nine muffles each 2 ft. 5½ in. wide, and four hearths in which the ore is rabbled by hand at right angles to the direction of the travel of the fire gases. The air for the muffles is preheated and the sulphur fumes leave the furnace with about 6 per cent SO_2. The capacity is 3 to 3½ tons of roasted ore with a coal consumption of 27 per cent; the ore remains in the furnace about 48 hours. Improvements were made in this furnace by cutting out the division walls between the muffles, so that the ore could be rabbled sideways along the hearths in the opposite direction to the travel of the fire gases; later it was found unnecessary to heat the upper parts of the furnace because the oxidation of the ore gives off sufficient heat, but before this stage was reached furnaces were built embodying almost every conceivable variation in the arrangement of the fire flues and the muffles.

Twelve years ago I still built furnaces with three superimposed muffles, the fire gases traveling beneath and above the bottom muffle, whereas it is only necessary, with proper design, to pass the fire gases under the bottom muffle. I found that in one part of the furnace the fire gas was no longer heating the ore but the ore was heating the waste gas.

For the sake of completeness I illustrate one of the later modifications of the Rhenania furnaces in Fig. 5. This furnace is 47½ ft. long by 17½ ft. wide, so that the ore travels a distance of 118 ft. along the hearths. With a 12-hour shift a total of eight men were required for the production of 6 tons of roasted ore per 24 hours. By working with eight-hour shifts only six men were required and the production per man per shift rose from 14 or 15 cwt. to 18 or 19 cwt. The coal consumption is about 25 per cent.

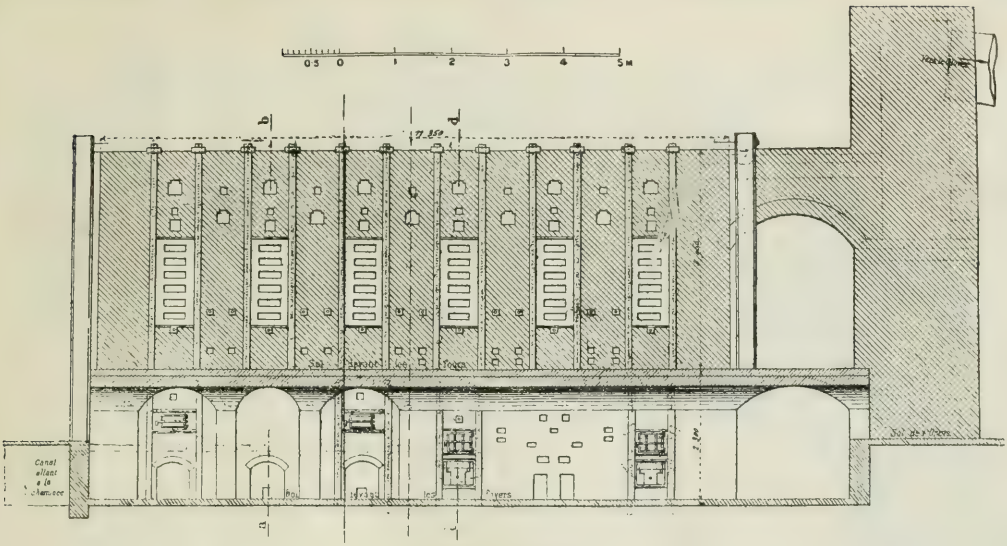
These furnaces have been generally built together in blocks of four and have been more largely used than any other type of furnace.

DELPLACE FURNACE

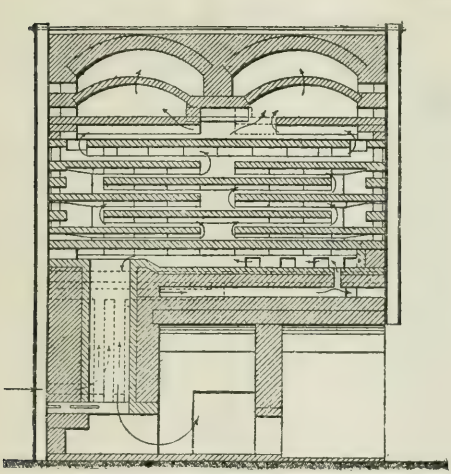
Owing to high price of fuel, "Delplace" furnaces have been largely built in Belgium since 1895. Fig. 6 shows the details of this furnace, which, with good labor, and if carefully built, gives satisfactory results. The travel of the ore on the seven superimposed hearths is only 40 ft., but the ore is exposed thoroughly to the air because the arches are low and only a thin bed of ore is maintained on each hearth. Only 16 per cent of coal is required for heating. These furnaces have been built mainly in Belgium and in France, but a few have also been erected in England and Germany. Experienced labor is required to work them satisfactorily and the men prefer to work on the Rhenania furnaces in which the ore is rabbled sideways, whereas in the Delplace type it has to be alternately pushed from and drawn toward the worker.

EARLY MECHANICAL FURNACES

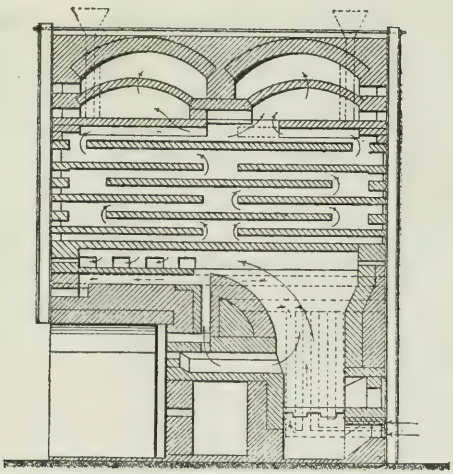
Work on zinc ore-roasting furnaces is most laborious, and even on the Continent continuous efforts have been made to replace hand labor by machinery ever since the start of the industry. The first attempt to do this was made by the Société de la Vieille Montagne, who succeeded in carrying out the first part of the operation in a furnace like a MacDougall roaster for pyrites fines —the furnace is shown in Fig. 7. The ore, after passing over three, or in some of the furnaces over four hearths, drops to two hand-rabbled hearths similar to those used in the Rhenania furnace. The mechanically stirred part had a diameter of 8 ft., but although various modifications of this furnace were tried it was not much used, mainly because of mechanical difficulties, which 40 years ago proved insuperable. The furnace is stated to have been able to treat 3½ tons of ore in 24 hours with 17 per cent of coal and ¾ hp.



Sectional Elevation



Section A-B



Section C-D

FIG. 6—DELPLACE FURNACE

In America, where hand labor was even more difficult to obtain, it was impossible to use hand furnaces. Hammond and Spence designed a furnace, which, although it is direct fired, is the forerunner of the Hegeler furnace, which has come so largely into use in the United States. In the Spence furnace the ore is rabbled along the various hearths by means of stirrers attached to long rods. This furnace shows the essential features of the Hegeler furnace, which is illustrated in Fig. 8. The Hegeler furnace, together with the end supports for the machinery, occupies a very large floor area; I understand that for the large furnace a total length of 360 ft. is required because of the runway for the stirrers at each end of the furnace; it treats 40 tons per day, with a coal consumption of about 25 to 30 per cent. The plows are drawn through the furnace by chains and, after passing through the furnace in one direction, are moved to the level of the next hearth and are then drawn through this in the opposite direction. This allows of cooling the stirring mechanism while outside the furnace. The capital outlay is large, and I have been informed that the repair bill of the furnaces working on the Continent is such that there is no appreciable saving in cost of roasting as compared with hand-rabbled furnaces. With eight-hour shifts 17 men are required per shift, so that there is no reduction in the number of men as against hand furnaces, but the men can mostly be ordinary unskilled labor together with a few mechanics.

Great things were expected from the "Merton" furnace, of which Fig. 9 illustrates the construction of a number of furnaces built in Tasmania; they have been

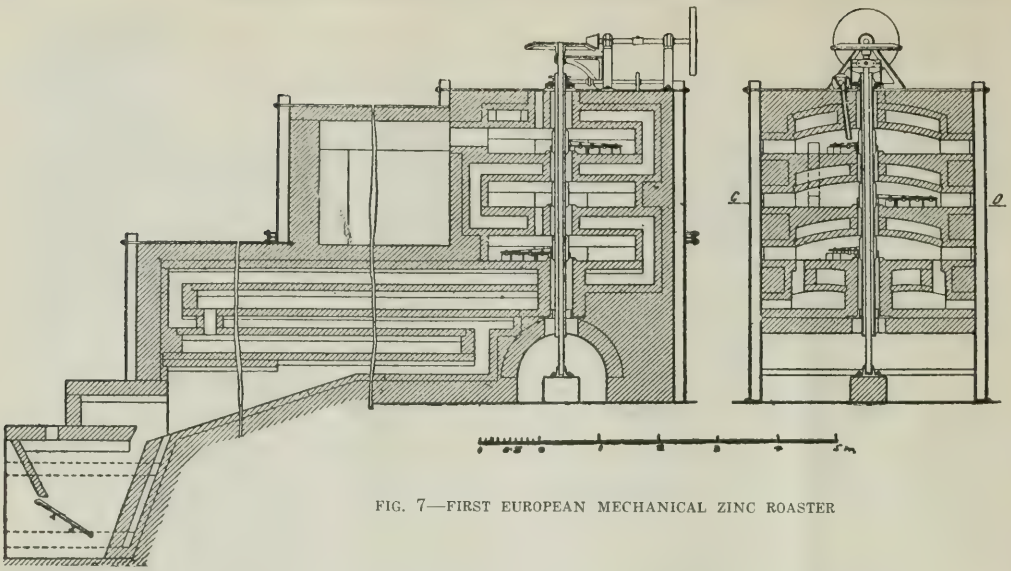


FIG. 7—FIRST EUROPEAN MECHANICAL ZINC ROASTER

found unsatisfactory and have been repeatedly rebuilt. They were not strong enough for the work and were redesigned before being built in Russia. No reports of the results of this installation have yet been published.

The Wedge furnace is now being tried on zinc ore in America.

Figures 10 and 11 show the Spirlet furnace, of which several were at work in Belgium and Germany at the outbreak of the war, and some have also been built in America. The capacity of the furnace is 3 to 3½ tons per 24 hours, and in consequence of there being no metal parts inside the furnace in contact with the ore the fuel consumption is low. The alternate hearths rotate and the ore is stirred by means of special bricks projecting downward from the hearth above. Good results have been obtained, but the campaign is short, and as soon as one or two of the projecting bricks, which stir the ore, wear or break off, the furnace chokes and has to be cooled down and put out of commission. I understand that on the Continent it has only been possible to work a furnace continuously for a maximum of three months before the arches have to be removed and overhauled, because no repairs can be carried out while the furnace is working.

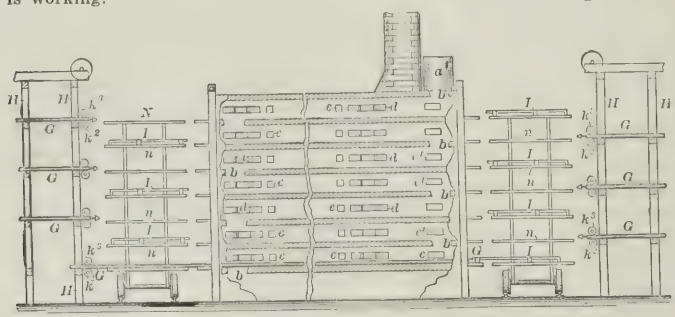


FIG. 8—HEGELER FURNACE
Longitudinal, vertical section

RIDGE MECHANICAL FURNACE

Figure 12 illustrates the general design of the Ridge mechanical zinc blende furnace, in which, after experiments extending over many years, the mechanical arrangements have been so far worked out that freedom from mechanical difficulties is assured, while the whole furnace is accessible. The shafts are each made in one piece and are water-cooled; about 15,000 gal. of cooling water is passed through the shafts in 24 hours to prevent overheating. The rabbles which stir the ore are easily and quickly renewed and the part to be replaced weighs only 5 lb. The ore is fed continuously to the drying hearth on top of the furnace and passes over three roasting hearths and finally to the cooling hearth, where it serves to preheat the air required for the oxidation. The mechanism of each furnace is driven by a separate electric motor which takes 8 to 10 hp. The motor and all the gearing are on a solid foundation beneath the furnace and fully accessible. The discharge opening is separated from the gearing by a brick wall to keep out all dust. The furnace runs noiselessly, the only sound being the hum of the motor. It is fired with producer gas which is burned only under the bottom roasting hearth. Broken Hill zinc concentrates are roasted down to 0.75 per cent total sulphur with a feed of 12 tons of ore per day of 24 hours and a coal consumption of 10 per cent. The sulphur fumes leave the furnace with 6½ to 8¼ per cent sulphur dioxide and at a temperature of 380 deg. C., so that they can be used satisfactorily in the lead chamber process. One man per shift can attend to the furnace and the producer.

Zinc concentrates with 14 per cent lead have been satisfactorily treated and also concentrates with 17 per cent iron. When roasting

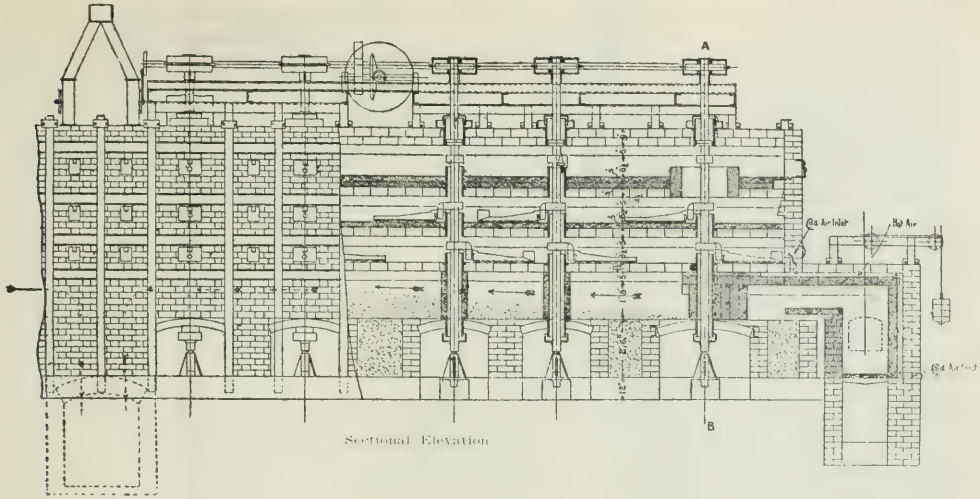


FIG. 9—MERTON FURNACE

an ore high in lead or iron, it is essential that a mechanical furnace be kept working continuously, because half an hour's stoppage means that the ore on the hearths sets hard and forms lumps which have to be broken up. It has been found possible in this furnace to use the rabbles for breaking up the lumps, and the gearing can, if necessary, be run alternately backward and forward till the hearths are free.

OPERATING DETAILS

I have dealt at length with the design of furnaces for roasting the ore, because this question has played such an important part in the past history of the art. The utilization of the sulphur contents of the ore, and, in fact, the treatment of zinc blende, has only become possible in consequence of the development of furnace design.

In some ores the presence of substances which interfere with the desulphurizing is important; lime, magnesium, strontium, and barium, if combined with sulphur, retain it in the roasting furnace; if combined with carbonic acid, this is driven off and in some cases the lime, etc., will take up sulphur from the ore. In considering the sulphur contents of roasted blende, allowance must be made for this combined sulphur. Lead becomes a nuisance in hand-rabbled furnaces, but in a properly designed mechanical furnace I have found no trouble; if ore high in lead is treated continually an accretion will form on the hearths, but the rabbles can be made to remove this. High iron content is found in some Spanish and German ores and makes complete roasting in hand furnaces almost impossible; in Germany, I was able, in a mechanical furnace, to reduce the sulphur left in the roasted ore to more than 1 per cent less than had been possible in hand furnaces.

USE OF SULPHUR DIOXIDE

The sulphur dioxide given off in roasting is utilized for making sulphites, liquid SO_2, or sulphuric acid.

Aluminium sulphate has been made at Flone in Belgium by passing the roaster gases into large chambers excavated in the hill side and filled with alum shale. At Ampsin this method was also used for making alum with gas from reverberatory furnaces; it seems that sulphite is formed and this readily oxidizes to sulphate.

The manufacture of liquid SO_2 was started by Grillo at Hamborn in Westphalia, because the fumes from the roasting furnaces were low in SO_2, and it was, at that time, considered impossible to utilize them for making sulphuric acid. The furnace gases pass to a scrubbing tower sprayed with water, which dissolves the sulphur dioxide, and the liquor gravitates to a series of pans, which are placed over the burners, the heat of which is sufficient to drive off the SO_2 gas. This, after being cooled, is compressed and liquefied at a pressure of 7 atmospheres. In Germany two plants are in operation, viz., one at Hamborn and another at Lipine in Silesia, but, in this country, the method has not been employed on the fumes from zinc ore. The demand for liquid SO_2 is limited.

The main commercial use for the sulphur fumes is the manufacture of sulphuric acid. This manufacture is well established at many smelters, and can be carried out in lead chambers, or by the contact process.

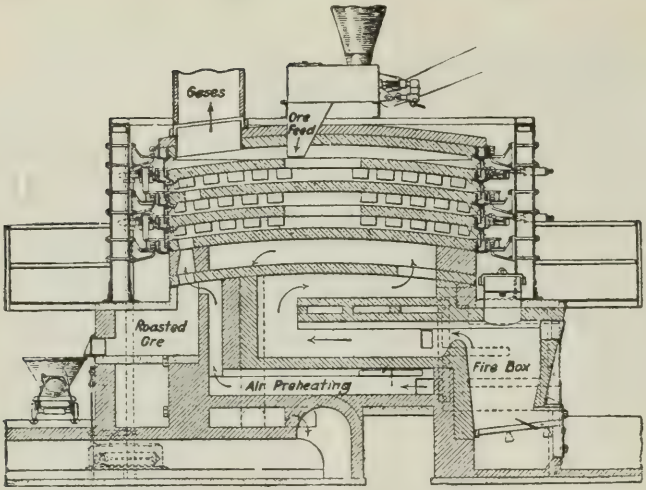


FIG. 10—VERTICAL SECTION THROUGH THE SPIRLET ROASTING FURNACE

EFFECT OF IMPURE GAS IN SULPHURIC ACID MANUFACTURE

Most zinc ores offer the advantage of being free from arsenic, but on the other hand they frequently contain fluorine of which even as little as 0.01 to 0.02 per cent becomes noticeable. Fluorine occurs with the ore as calcium fluoride, which is decomposed in the roasting furnace in the presence of silica and forms silicon fluoride. If this gas passes into the Glover tower it is decomposed and hydrofluosilic acid is formed; this, in turn, appears to split up. As it is usual, when treating zinc ores, to circulate the tower acids, the fluorine contents seem to remain in the circuit so that the attack on the packing of the towers gradually increases, but, contrary to expectation, I have not found increased corrosion of the lead work of the chambers by fluorine. Many efforts have been made to overcome the trouble with the packing. Glover towers have been built entirely of lead, and with lead sheets as a packing, so as to avoid the use of silicious material, but it is found necessary in this case to use two Glover towers in series, the first one being an empty tower followed by a tower filled with suspended lead sheets. I have found it preferable to overcome the trouble by passing the whole of the chamber acid through the towers instead of only circulating the tower acids, and by this means keeping down the fluorine contents of the acid, and at the same time to pack the towers with a well-burnt brick packing of a suitable composition which would offer the maximum possible resistance to the attack of hydrofluoric acid. Glover towers built in this way, and properly operated, have been worked continuously for 12 months and longer without trouble.

Other important impurities affecting sulphuric acid manufacture are antimony, mercury, and chlorine.

Some years ago I experienced trouble in consequence of the unexpected presence of chlorine, and on investigation I found that this was due to the ore having been left lying for several months on the Wharf at Port Pirie, and sprayed with sea-water in order to avoid loss by windage.

Mercury is found in some Spanish blendes. It collects at the outer parts of the dish of the lead chamber, where it is not protected by lead sulphate and causes rapid corrosion of the lead. This can be overcome by lining the sides of the dish with thin brickwork.

Antimony occurs frequently in small quantities with zinc blende, and at the high temperature of the roasting furnace some of this is volatilized and passes into the acid. On one occasion I received serious complaints about the presence of arsenic, but found, on examination, that antimony was the cause of the trouble. Antimony was found in the zinc concentrates from Broken Hill when treating ore from the upper levels in one of the mines, but the quantity present was less than 0.03 per cent.

Most zinc ores have lead associated with them, and some of this is generally driven off with the sulphur in the roasting furnace together with the silver which is combined with the lead, but both the lead and the silver are deposited in the chamber sludge.

SULPHURIC ACID PLANT OPERATION

The lead chamber process, when working with hand furnaces, has to be carefully watched because of the intermittent evolution of sulphur dioxide in consequence of intermittent rabbling of the ore. In Germany it has been usual to reduce this difficulty by arranging for the furnace hands, working on the different furnaces, to start their shifts at different times, but, in spite of this, it is not possible to obtain a continuous current of uniform gas throughout the 24 hours, and, unless the

FIG. 11—VIEW OF ONE OF THE HEARTHS OF THE SPIRLET FURNACE

process is watched carefully, loss of nitre is the result. With modern mechanical furnaces this trouble does not occur.

The design of the chamber plant does not call for special comment. It is in every way similar to that used when burning pyrites. The nitre consumption, and working cost of the plant, are not higher than with pyrites. In England and in Belgium lead chamber plants have been used exclusively for making acid, and in Germany this is also the rule, but there are several contact acid plants at work as well. In America 14 zinc smelters make sulphuric acid, but they mainly use the contact process.

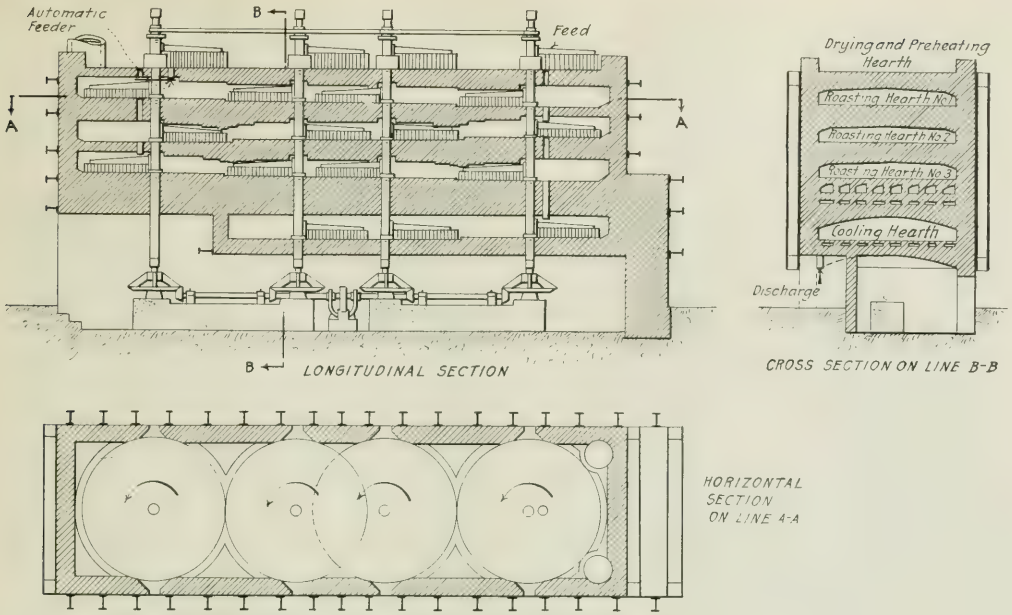


FIG. 12—RIDGE FURNACE

Calculated as 60 deg. B. acid, the American production from zinc blende was:

In the year 1911—230,643 short tons.
1912—292,917 short tons.
1913—296,218 short tons.
1914—411,911 short tons.
1915—484,942 short tons.

The average price realized in 1915 was $8.85 per short ton.

The use of the contact process for fumes from zinc ore made the biggest strides in the United States, because there the smelters are largely able to rely for their ore supplies upon the produce of one or more mines, and are not dependent upon small parcels of ore shipped from various parts of the world, as has been the case in England and on the Continent. They have consequently been able to make provision for eliminating any harmful ingredients which may be present in the raw material which they expected to be treating for a long period. The American smelters also have the advantage of having practically no hand-rabbled furnaces.

The various contact poisons can be eliminated if the tonnage to be treated warrants the initial expenditure on the plant. Fluorine, arsenic, antimony, and lead can be removed by first scrubbing the gas with a suitable liquid, and when this is done the conversion offers no greater difficulties than when brimstone or pyrites is burnt.

In England, acid has only been made from zinc ore in three plants, and I estimate that their output does not exceed 25,000 tons a year of 140 deg. Tw. acid. This tonnage corresponds to a production of about 10,000 tons of spelter. In 1913, 31,290 tons of virgin spelter was made in the country. Part of this was made from calamine, but the available supplies of this ore are steadily decreasing, and it is only a question of a short time, when the whole of the metal will have to be smelted from zinc blende. The position is really worse than is indicated by these figures, because it has been customary to roast the sulphide ore in reverberatory furnaces from which the fumes cannot be used, so that the sulphur is wasted and the atmosphere polluted.

PRE-WAR GERMAN PRACTICE

To illustrate the importance of the utilization of the sulphur of zinc ores I will refer to the figures for Upper Silesia. The district produces about 60 per cent of the spelter made in Germany, but a good deal of calamine is still available there, so that the maximum production of sulphuric acid from blende has not been reached; the tonnage of calamine treated steadily decreases, but the increased amount of blende compensates for this, and allows of an increasing spelter and acid production. The last figures available are for 1911, and the accompanying table shows the results for every fourth year since 1887.

STATISTICS FROM UPPER SILESIA

Year	Raw Blende Roasted. Metric Tons	Sulphuric Acid Reduced to 50° B. Metric Tons	Sale Value Total Marks	Sale Value Metric Ton of 50° B. Acid
1887	53,882	21,013	479,000	22.81 marks
1891	66,236	32,676	746,000	22.85 marks
1895	81,857	33,229	778,000	23.43 marks
1899	123,602	64,029	1,074,000	16.77 marks
1903	187,596	104,268	1,728,000	16.62 marks
1907	424,006	139,840	2,187,000	15.65 marks
1911	411,352	213,317	3,025,000	14.18 marks
1912	.....	254,008	.....	....

1 mark = 23.8 cents.

Six works still used their old reverberatory furnaces, so that not all the sulphur could be utilized, but for some years factory legislation has prohibited the emission of noxious fumes and as the plants become worn out they have to be replaced by modern installations.

The fumes from the reverberatory furnaces are scrubbed with milk of lime which is sent to waste. Five plants have lead chambers and make acid of 50-55 deg. B.; this is generally concentrated in cascades or Kessler apparatus and in recent years largely in Gaillard towers. Three works have contact plants as well as lead chambers. There was in 1912 a total of 48 lead chambers.

Of the total production of acid, 41,055 metric tons was sold as acid of 50 deg. B., 114,346 metric tons was sold as acid of 50-60 deg. B., 42,349 metric tons was sold as acid with 98-100 per cent H_2SO_4, 216 metric tons was sold as oleum with 20 per cent SO_3, 4774 metric tons was sold as SO_3, and in addition 2855 metric tons of liquid SO_2 was made.

The acid is used for making superphosphates, sulphate of ammonia, dynamite, and guncotton, and for refining mineral oil. It is distributed by rail over a wide area, some going into Russian Poland, Austria, Hungary, and even to Roumania.

The position in the zinc smelting districts in Western Germany is analogous, but there the make of acid is larger in proportion to the production of spelter, because there is no local supply of calamine. The newer smelting works have been placed on navigable waterways so that freights on raw materials and finished products are low. The chamber process is used in all the works except one which has a contact plant; there is also one installation making liquid SO_2.

In 1913 in Germany 554,760 metric tons of blende was roasted for making sulphuric acid; of this 87,439 tons was imported from Australia and 56,181 tons from other countries.

In Belgium blende is mainly roasted by the chemical manufacturers, who retain the sulphur and receive from the zinc smelter in addition a payment of $1.20 to $1.60 per metric ton, for roasting the ore. This was facilitated by the low freights on the canals, which reduced transit charges to a very low figure. In Belgium 65 per cent of the total production of sulphuric acid is made from blende; the amount of zinc acid is nearly 400,000 tons.

ENGLISH SITUATION

The most important and serious factor for consideration here in England is the shortage of zinc smelting capacity in the country. In 1913 our consumption of spelter amounted to no less than 224,000 tons of which 74 per cent was imported. After allowing for the metal made by the refiners, we imported about 166,000 tons of spelter and zinc in other forms. If this quantity were all made from blende, the roasting fumes could be used to produce annually 400,000 tons of 140 deg. Tw. acid. There is no reason why this should not be done and the corresponding quantity of brimstone and noncupreous pyrites displaced as well as a portion of the pyrites which is low in copper.

Before the war the cost of making 140 deg. Tw. acid from zinc ore fumes in this country was only between $1.95 and $2.20 per ton, so that the operation is remunerative and profitable.

Zinc ore must be treated because spelter is required, and if the work is not done here, it will be done elsewhere. Cheap sulphuric acid has always been an important factor in the chemical industries, and unless we use the resources of the Empire, others will do it for us and we shall be obliged to continue to look on while the foreign subsidiary industries using the acid abroad go ahead.

Several of the illustrations reproduced in this paper are taken from Liebig's "Zink und Cadmium," Ingall's "Metallurgy of Zinc and Cadmium," Prost's "Cours de Métallurgie de Métaux autres que le Fer," and "The Engineering and Mining Journal."

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Meter Accuracy on Arc Furnace Loads

In electric arc-furnaces used in making high-grade steel, the current wave shape is at times greatly distorted. A member of the Committee on Meters of the Technical and Hydro-Electric Section of the National Electric Light Association reports that the accuracy of an induction meter on this service was questioned because the magnetic and electrical characteristics of iron vary somewhat with the shape of the current wave. On account of the rapidly fluctuating load, indicating instruments could not be used, and dynamometer-type watt-hour meters without any iron in their magnetic circuits were specially compensated for inductive loads and used as standards, and the readings of the induction-type watt-hour meter compared therewith. The meters were installed on the secondaries of current and voltage transformers. A large number of tests were taken under various conditions of furnace operation, and the dynamometer and induction-type meters agreed to within 1 per cent. The instrument transformers were tested by the Electrical Testing Laboratories under artificially distorted wave forms, and were found to be accurate. The laboratory wave forms were not quite as irregular as the actual furnace current waves, but were severely distorted, and as they produced no appreciable effect on the transformer accuracy it was assumed that the effect of the slightly greater irregularity in the furnace wave would be negligible. It was concluded that under the conditions existing in this installation the accuracy of registration of the customer's meter was well within commercial limits, and was not seriously affected by the irregular wave form.

It is important to note that in the furnace electrode circuits considerable direct current was present, due probably to rectification in the arc, and consequently the current wave shape was unsymmetrical with respect to the zero line. The general shape of the wave was such as would be produced by superposing direct current on alternating current, and it was found that current transformers had large errors on this type of wave. If, therefore, the customer's meter had been placed in the secondary circuit of the supply transformers, instead of in the primary, serious errors in registration would probably have resulted. Pending further investigation, it is therefore recommended by this committee that if arc furnace loads are metered on the secondary side of the supply transformers, the accuracy of the metering should be investigated. If metered on the primary side of the supply transformers, errors will be avoided as the direct current in the electrode circuits cannot reappear on the primary side, hence the primary current wave is symmetrical with respect to the zero line. Summing up the results, it appears that no serious error is produced by an irregular current wave form, but if the wave is unsymmetrical with respect to the zero line considerable error may occur.

The Production of Salt in Szechuen Province, Western China—II

By H. K. Richardson

In a former article, in this journal, Jan. 1, 1917, p. 32, a description was given of the most famous salt wells of Szechuen province, China, those at Tzeliutsing. The present article will deal with the more numerous type of wells, those of moderate depth, about 1000 ft. This type of well can be found all over the salt well district (see map in former article), sometimes in groups and sometimes as isolated units. The largest collections are in order of their size found at Tai Ho Chen on the Chengtu-Wan Hsien post road, at Chein Wei Hsien near Kiating on the Min River and near Chien Chou on the Chengtu-Chungking Big road. The technique at the various places is very similar, the main difference being in the means employed to raise the brine. At Chien Chou the brine is raised by cows using a horizontal wheel on a smaller scale like that at Tzeliutsing, while at the other two places a vertical wheel operated by man power is in use. In all three places the supply of brine is limited, dependence on natural seepage of water to the salt deposit being universal, so that the raising process is intermittent.

A well visited in the Tai Ho Chen section is typical of this class of wells. The facts gained from the owners and operators will be given below.

The first operation is to locate the place to drill the well. For this purpose the owner calls in an expert called in Chinese, the "Salt Well Look Master." This man takes a stick and prods over the land until he is satisfied that a successful well can be driven. His word is taken and drilling commences at the spot he indicates. How often the look expert makes a mistake is not stated, but the number of unsuccessful wells in these territories is apparently small.

DRILLING

The spot settled upon the first operation is the construction of a winding drum, which will serve as the drilling drum and later for the winding drum of the finished well. Fig. 1 shows one of these drums set up by the side of the road. These drums have the following dimensions:

Diameter of the wheel	10 to 12 feet
Width of face of wheel	4 feet
Number of spokes in wheel	12
Material of wheel	Bamboo
Material of Hub	Pine Wood

The slats on the face of the wheel extend over the edges so as to give the men a footing when operating the wheel treadmill fashion. The rope which holds the drill or the bailer is wound over the periphery of the wheel between pegs. The winding drum finished, the top of the well shaft is sunk. A hole is dug about 40 ft. deep and lined with a wooden tube made by hollowing out a tree trunk. This serves as the drilling guide to insure vertical drilling and later as the top of the well. The construction of the top of the well is seen in Fig. 2. The drilling is done with a flat face spud drill (Fig. 3), 5 ft. long, above which in a bamboo case is a sinker bar about 15 ft. long. The whole outfit weighs about 150 lb. The actual drilling operation is simple, three men stand at the back of the drum and pull it back against a stop, then release the drum which flies back against another stop. During this operation the drill is raised 4 in. and suddenly dropped. This performance is kept up until the hole clogs with debris when a sand sucker or bamboo tube is lowered into the hole and the place cleaned out. In soft sand and hard clay progress at the rate of 8 ft. a day is the average. Tradition has it that 120 days is the average time to drill wells in this district. This would make the average well 1080 ft. deep. As an example of how trustworthy the average given by a Chinese is, the following figures are interesting: The rope strands on several wheels were counted: One wheel gave 27 layers on 12-ft. wheel or

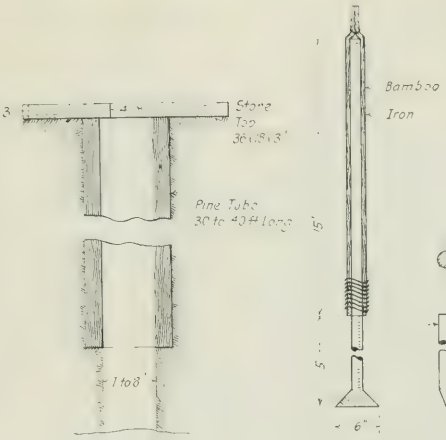

FIG. 2—WELL THROUGH CLAY AND SANDSTONE 1000 FT. DEEP

FIG. 3—FLAT FACE DRILL

FIG. 1—WINDING DRUM

FIG. 4—EVAPORATOR HOUSE, TAI HO CHEN

1020 ft. + 60 ft. (Bailer) = 1080 ft.; another wheel gave 33 layers on 10-ft. wheel or 1037 ft. + 60 ft. (Bailer) = 1097 ft.

RAISING THE BRINE

The brine is brought to the surface in a bamboo tube or bailer 60 ft. long, 1½ to 2 in. inside diameter holding about 83 lb. of brine. The bailer is supported by a bamboo rope made by splitting bamboo into strips 1 in. wide by 3/16-in. thick, and tying the needed number of sections together. Only two lifts are made a day, one in the early morning before the farmer starts his daily routine and one in the late afternoon as the sun is setting. It was an interesting experience to listen to the squeaking of the wheels as the farmers singly or by pairs laboriously, treadmill fashion, droned away the twenty or more minutes needed to bring the 80 odd pounds of precious salt brine to the surface. The salt is in about a 10 per cent solution. Nearly all the wells are operated by farmers as an adjunct to their regular work. The investment in one of these wells, not including the land, is small, about $36 on the average for the well, drilled and fully equipped. The brine is sold to the nearby evaporator on the basis of its salt content; the farmer makes about 5 cents a day or 40 per cent on his investment without considering his time.

These wells are very popular with the farmers in this district. In a journey of about 20 miles we counted from the road 475 wells, and 14 evaporator houses.

EVAPORATION OF BRINE

There is usually one evaporator situated about at the center of 30 wells. Fig. 4 is a photo of one of these houses. They are about 40 by 40 ft. and easily distinguished by their monitor roofs from which steam is always escaping. The arrangement of these plants follows one general plan such as given in Fig. 5. An interior photo is shown in Fig. 6. Probably since the first evaporator started they have followed the same scheme of operations as is given in the flow sheet which follows:

FIG. 6—INTERIOR OF EVAPORATOR HOUSE

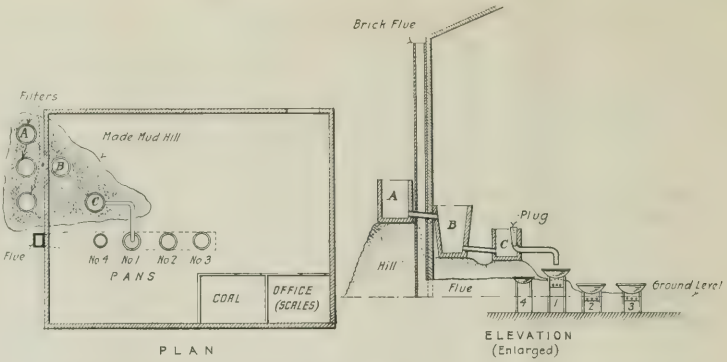

FIG. 5—ARRANGEMENT OF PLANT

FLOW SHEET OF EVAPORATOR

Letters refer to Fig. 5
Brine dumped on Filter A—5760 lb. per 24 hours
Filters to (B)
Filters to distributing tank (C)
To Pan No. 1
Drips slowly from Pan No. 1 into Pans Nos. 2 and 3

Scum	Brine
To pan No. 4 (waste heat)	Evaporated to dryness
Dried in pan	2" salt layer broken up for market
Sold for use in making bean curd	Yield per day about 165 gin per pan
This is $CaSO_4$	Total pans 2 and 3 . 440 lb. salt

Yield per day 7 lb. Value 1 cent Value—$5.94

The balance sheet of this evaporator as best we could get it from the man on duty is as follows:

Income for One Day

440 lbs. salt	$5.94
7 " $CaSO_4$	0.01
	$5.95

Outgo for One Day

800 lbs. coal	$2.35
36 loads brine	1.80
4 Workmen wages	0.27
Interest on investment and repairs to pans	0.40
	$4.82

The investment, as we were able to piece it together from the information given by the owner and our own experience, is as follows:

Building	$350.00
Pans	100.00
Tools, scales and misc.	50.00
Total	$500.00

The technical results obtained at this evaporator compared with those on the Chien Chow district are of interest.

	Chien Chow	*Tai Ho Chen*
Depth of well	500 ft.	1000-1100 ft.
Motive power	Cows	Human
Brine strength	12%	10%
Coal consumed per lb. of salt obtained	3.2	1.8
Pounds of water evaporated per lb. coal	2.8	6.7

The location of the wells in both districts, clustered around the bottom and partly up the sides of low hills, (60 wells were about a single small hill) suggests that the deposit from which they all were fed is a rock salt bed underlying the whole section. This deposit, if worked by a shaft and modern mining methods or by forcing down hot water as is done in some of the wells in the Middle West would yield its wealth with much less labor than is needed by the present methods.

A concluding article of this series will describe the well at Kwei Chow Fu, which has a technique all of its own and very interesting to the chemical engineers.

The Estimation of Petroleum Reserves*

By Robert W. Pack†

INTRODUCTION

Sooner or later in the development of any natural resource it becomes highly desirable to know the quantity of this resource in the country as a whole, as well as of the part that is being developed, for the general course and conduct of the development work must be governed to some extent by the total supply available. An accurate estimate of the quantity of any natural resource is difficult to make; yet if one is diligent enough one can obtain a pretty accurate idea of the quantity of marketable timber, the acreage of tillable land, or the horsepower that may be developed from the streams, for these are things that may be measured. But any attempt to estimate the quantity of some mineral in the ground appears to enter the realm of imagination and it seems that the estimate can be nothing more than a blind guess. It may appear to be especially futile to attempt to determine the quantity of oil and gas that is available in the ground, for these minerals are so vagrant that even if the quantity now available should be known quite exactly, the quantity that will eventually be obtained may be much less, for certain losses in the extraction of both oil and gas are unavoidable, and just what these losses will be cannot be predicted.

Though necessarily inaccurate, estimates of such mineral reserves are, however, of distinct value, for they summarize the existing knowledge of the deposits of the mineral and thus enable those who are interested in some industry that depends in one way or another on this mineral to formulate a rational commercial policy.

Some time ago, when the price of gasoline suddenly rose in a rather spectacular manner, the writer was one of the U. S. Geological Survey geologists called upon to help to estimate the quantity of oil that could be obtained in the United States, for the fear had become widespread that perhaps the rate of increase in the price of gasoline was a measure of the rate of depletion of the supply of petroleum. It thus became his official duty to make some sort of an estimate of the quantity of oil that still remained available in the ground in California. In making this estimate the writer attempted to predict the future output by a study of the past output of the productive fields, for such a mode of prediction is generally by far the most satisfactory one that can be used and has been employed in one form or another a great many times. There are, however, various ways in which historical and statistical data may be used, some being best suited for one set of conditions, some for another. The writer believes that the particular methods which he used in handling the data, and which are described below, are peculiarly adapted to the conditions in California, and that they are in considerable part new.

It is the purpose of this paper (1) to outline briefly one or two of the methods that have been used by others in estimating the available supply of oil, and (2) to describe somewhat more in detail the methods used by the writer, and to state why such methods were chosen and what degree of accuracy can be attained by using them. The general method followed might be applied to any oil field, provided the necessary data are available.

There are two general methods of estimating the quantity of oil and gas in the ground. The first of these to be described is what is commonly known as the saturation method; the second has been termed the production curve method. The two methods are not quite comparable, for the first is used to determine the quantity of oil in the ground, and the second the quantity of oil recoverable, assuming that the conditions governing production will continue to be about the same as they have been in the past. The two methods likewise have separate applications, for the saturation method may be used to determine roughly the quantity of oil or gas in an area that has not been tested, whereas the production curve method is applicable to a partly developed field but only indirectly to an undrilled area.

SATURATION METHOD

The saturation method consists essentially of a determination: (1) of the volume of the strata that serve as reservoirs for the oil; (2) of the porosity of these strata—that is, of the "voids" in them—and thus of the maximum volume of the space that may be occupied by the various fluids; and (3) of the percentage of the "voids" that is occupied by oil. This method is the one that has commonly been used ever since estimates of the oil reserves of the country were first attempted. The method has recently been described in some detail by Washburne.[1]

The saturation method obviously involves the consideration of several factors that cannot be measured directly. The first factor to be considered—the volume of the sand that serves as a reservoir—is the factor that may be determined most accurately, and in fields where the strata show relatively little variation in lithology and thickness over large areas, such as the Appalachian fields, it may be possible to calculate the volume with considerable accuracy from measurements made on the outcrops of the oil- or gas-bearing sand, or from those given by a few scattered wells. In a very great many areas, however, and of these the California fields are fairly typical, the formations are so lenticular and the reservoir sands so inconstant both in thickness and in lithology that no reliance can be placed on the calculations of the volume of the reservoir made in this manner, even if the points at which the measurements were made lie fairly close together.

The second factor, the porosity of the reservoir sand, is even more difficult to estimate. In making an estimate of the oil, it is clearly useless to determine the porosity of the oil-bearing sands in areas where the total volume of the strata cannot be determined with some degree of precision; but even in areas in which the thickness of the formations is fairly constant, and in which the volume of the beds acting as reservoirs may be calculated with fair precision, the porosity may vary greatly, either because of variation from place to place in the grain of the rock or because of the local introduction of a secondary cement that occupies a considerable part of the original void space of the rock; and the variation may be so great that the space which may be occupied by fluids cannot be calculated. In these areas the porosity of the oil-bearing bed as determined from samples of rock taken on the outcrop or from a few samples obtained in drill holes is apt to be very differ-

*A paper to be presented by permission of the Director, United States Geological Survey, at the St. Louis meeting of the American Institute of Mining Engineers.

†Geologist, United States Geological Survey.

[1] C. W. Washburne: (1915) 51 Trans. A. I. M. E. 645.

ent from the average porosity of the stratum over a large area.

The third factor, the percentage of the void space that is occupied by oil, is, of course, not directly measurable, so that it is necessary to assume either that the voids are all so occupied or that some arbitrarily chosen proportion of them are.

Should all these different factors be correctly determined, the resulting figures will record the total quantity of oil in the field. Not all this oil is recoverable, however, and the figures so obtained must be mutiplied by an "extraction factor" in order to obtain figures that will represent the available oil.

Even under the most favorable conditions, then, the saturation method is capable of giving only a rough approximation of the recoverable oil in any area; but rough as it is, this method has a distinct value, for it will give directly a first approximation of the maximum amount of oil to be expected from an untested or very sparsely drilled area in which the formations are fairly constant in thickness and lithology. This method is not, however, applicable to areas where oil is held in solution cavities or in fracture zones, nor is it of any very great value in the consideration of pools that occur in the variable Tertiary strata of California.

PRODUCTION CURVE METHODS

The production curve method is a mode of predicting the future production of an area and is based on a study of the past production of that area. The method is largely graphic, and although various modifications of it have been used, all are essentially extrapolations of one or more curves that show the production or development of the field. The advantages of this method over the saturation method are: (1) it is concerned with actual production, so that the assumption of any "production factor" is unnecessary; (2) the factors that must be estimated or assumed are fewer and on the whole less liable to great variation than those that must be estimated or assumed for the saturation method.

Two general methods of using production figures are employed in estimating the reserves of oil in a given area. One uses figures showing the production per unit of time of the whole field or of a group of fields within a given area; the other concerns itself only with the production of certain small areas, which are considered as types, the results obtained in their study being applied to the field as a whole.

In support of the first method, it has been urged that a consideration of the combined production of a large number of wells and of wells distributed over a large area automatically takes account of various irregularities in the production of individual wells—of irregularities due to variation in demand, to increased drilling, and to the discovery of new pools—it being always assumed, of course, that the conditions in the future will vary about as they have varied in the past. But in the very fact that the curve incorporates these factors lies its weakness, for in the nature of things drilling cannot continue indefinitely into the future, nor is it reasonable to expect the continuous discovery of new pools. These two factors should therefore be taken into account separately, and their effect should be eliminated from the curve showing total production.

The second method—that of studying the history of a small group of wells—has an advantage in that it permits a more intensive study, but it has a disadvantage in that the data necessary for this study are much more numerous and are seldom available. Moreover, in applying to the whole field the results obtained in the study of a small part of it, it is necessary to estimate the degree in which this area represents the conditions that exist throughout the field.

METHOD USING THE RECORD OF THE PRODUCTION OF THE ENTIRE FIELD

Probably the simplest method of predicting the future of a field is to project the curve that represents the field production per unit of time. Such a method will give reasonably correct results only for an old field in which the production of oil per unit of time has been constantly decreasing. When applied to the Appalachian fields it gives fairly satisfactory results. The method of representation shown in Fig. 1, in which the shaded area below the line *ABC* represents the volume of oil that has been produced to date from an old field, that has long been producing a constantly decreasing quan-

FIG. 1—ESTIMATION OF RESERVE OF PETROLEUM BY EXTRAPOLATION OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME

tity of oil in a given length of time. Assuming that this rate of decrease will continue until the field is completely drained, the amount of oil now remaining in the field is represented by the unshaded area below the line *CD*.

This method of prediction is open to the criticism that it does not discount the effect of new wells but that it tacitly assumes that new wells will continue to be drilled up to the very moment that the pool is drained, or, if the curve represents the production of a large area rather than of a single pool, that new pools will continue to be discovered up to the moment when the oil in the region is exhausted.

CURVE SHOWING PERCENTAGE OF DECREASE IN PRODUCTION

A variation of the graphic method of estimating reserves just described is to plot, not the figure showing the actual quantity of oil produced, but a figure showing the relation between this quantity and the maximum quantity of oil that the field has produced during some unit of time. The curve so obtained—the so-called percentage curve—was used by Arnold, and Fig. 2 is adapted from his plate.[2]

This mode of estimating oil reserves, like that just described, is applicable only to those fields that have passed the zenith of their productivity and are producing in any unit of time a constantly decreasing quantity of oil. The curve in Fig. 2 represents the life of the field after the time when the maximum yield per unit of time was obtained. It is so constructed as to show the quantity of oil obtained during each unit of time that followed the period of maximum yield, the quantities being expressed in percentages of that maximum. This method is also open to the objections that have just been raised against the method of projecting

[2]Ralph Arnold: The Petroleum Resources of the United States. (December, 1915), 10, *Economic Geology*, 695-712.

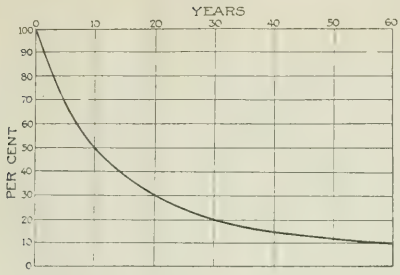

FIG. 2—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF "THEORETICAL CURVE OF FINAL DECREASE"

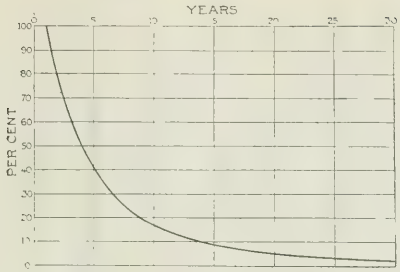

FIG. 3—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING PRODUCTION OF AVERAGE WELL EXPRESSED IN PERCENTAGES OF PRODUCTION OF WELL DURING FIRST YEAR OF ITS LIFE

the curve that shows the total production directly, particularly to the objection that it in no way takes account of the effect of new wells. The sole object of plotting the statistics of production in this form was to obtain a curve that would serve as a type to show decline in production for any and all fields. The rate of decrease in production, however, is so different for different fields that it seems very doubtful whether a single curve can express the decline for more than a single field, or perhaps for a group of fields in rock of the same general type or of the same general geologic structure.

This method of plotting production in terms of percentages of total production is essentially an attempt to apply to the country as a whole the methods employed by the California evaluation committee, whose work is explained below. That committee, however, concerned itself with small areas for which a mass of detailed information was available and constructed a number of curves, each showing the rate of decline for a certain particular field. An inspection of these curves, all of which were prepared for fields in California, shows that even within that State the decline is different for different fields. It is evident that similar curves constructed for fields in Oklahoma and Pennsylvania would show still greater differences. Moreover, the production curves of the evaluating committee were so constructed that the effect of continued drilling is to a measure discounted. The "theoretical curve of final decrease" used by Arnold does not in any way consider the effect of drilling new wells, but, like the method shown in Fig. 1, assumes that drilling will continue up to the very moment that the field is totally drained. This method, therefore, has less to recommend it than the method of projecting the curve showing the exact quantity of oil produced in some unit of time.

METHOD USING RECORD OF THE PRODUCTION OF SMALL AREAS

Some time ago, when a plan was on foot to combine certain producing properties in California, it became necessary to determine the relative value of the different properties, and especially the reserves of oil contained in each. A committee, of which M. L. Requa was the moving spirit, attempted to determine the reserves by making a detailed study of the history of the wells. The method that they followed was essentially the study of a small area in great detail, and the application of the results of this study to the field as a whole. The immediate problem was not to determine the reserve of oil in the whole field, for that was of only incidental interest, but the amount remaining in certain parts of the field. The areas studied, however, were regarded as types of the fields or of the parts of the fields in which they lay, and the curves showing the predicted production for the small parts were applied to the whole field.

Then, too, the manner in which they used the record of the production of the wells was unique. Instead of plotting a curve that showed the rate at which oil had actually been taken from the area—that is, instead of constructing what might be termed a chronologic curve—the figures showing the production of the wells were so grouped that the quantity of oil obtained from a well during each year of its life was grouped with the quantity of oil obtained from all the other wells during the corresponding years of their lives, irrespective of the actual time at which the wells were drilled. Thus, although well *B* may have been drilled 10 years later than well *A*, the oil that well *B* produced during each year of its life was grouped with the oil that well *A* produced 10 years before. The figures showing the production of the wells as thus grouped were then expressed in percentages of the production of the first year, and this curve was taken to represent the production of the average well in the area. To get a figure representing the quantity of oil that the average well will produce, it is necessary only to determine what the average production during the first year of their lives has been for the wells that have been drilled, and to substitute this number in the curve. The oil produced during the following years is then expressed in percentages of this number.

In order to obtain a figure representing the total production of an area, it is necessary to determine the number of wells that would be necessary to drill the area completely, and to multiply this number of wells by the figure showing the total quantity of oil obtainable from the average well, as shown by the curve. A curve constructed for one of the California fields is shown in Fig. 3.

This method has the distinct advantage over the methods hitherto described in that it attempts to determine the effect upon production of the rate at which new wells are drilled. The degree to which this discounting is really effected is, of course, dependent in large part upon the degree to which the property is drilled, for the mutual interference of wells increases as wells are multiplied.

METHODS USED BY THE WRITER

In casting about for some way in which to estimate the oil reserves in California, the writer, after consid-

ering the methods just described, concluded (1) that the production curve rather than the saturation method should be used in estimating the reserves in the producing fields, and (2) that the untested areas should be estimated by comparing them with the producing areas that they most closely resembled geologically, after the reserves in these areas had been estimated by the production curve method. The best way of handling the production record did not seem to be quite so clear, for none of the methods appeared quite to fit the requirements. It seemed better to use a method that considers the production of the whole field rather than with one that considers only a small part of it, both because the data necessary for the detailed study of a small area are seldom available and because of the difficulty in choosing areas that might fairly represent the whole field. It appeared, however, that in dealing with the record of the total production some way should be found to discount the effect of the new wells.

METHODS USING FIGURES SHOWING FIELD PRODUCTION

In order to fulfil approximately these requirements, the method described below was devised. Fig. 4 shows the application of the method to a California field:

1. The field production per unit of time was plotted and a curve, *ABCF*, similar to that in Fig. 1 was obtained.

2. Two points, *B* and *C*, which represented dates when the field production was the same, were selected. These points were as far apart as possible and corresponded to the general level of the curve about them—that is, they represented dates when the field production was fairly constant.

3. The number of the new wells drilled between the two dates represented by points *B* and *C* was then determined, this, of course, being a matter of record, and,

4. The number of new wells required to drill the field completely was then estimated from a knowledge of the geology of the field, it being assumed that the manner of locating wells would in the future be about the same as it had been in the past.

These factors having been determined, the supposition was made that, if new wells were drilled after the time represented by the point *C* at the same rate as they had been drilled during the period represented by the line *BC*, the production of the field would be maintained at a constant figure. This is not precisely correct, for the initial production of the wells that are drilled late in the life of the field is not nearly so great as that of the wells drilled while the field is new. The number of new wells necessary to maintain production will therefore increase as the field grows older. An idea as to this rate of increase in the number of wells necessary, may be obtained from a study of a cumulative curve showing the time at which new wells have been drilled and a curve showing the production of the field. The correction may be neglected in making the first approximation of the reserve of petroleum in a field, for other factors which enter into the calculation are liable to so great error that such a refinement seems insignificant, but in making a detailed study of a small area where a considerable number of reliable data are available, such a correction should be made. When the rate has been determined at which the drilling of new wells must progress in order to keep the output of the field constant, the time at which the field would under these conditions be completely drilled is calculated. This time is represented on the diagram by the point *D*. The quantity of oil which under these conditions would be produced between the time represented by point *C* and the time represented by point *D*—the time at which the field would be completely drilled—may be calculated or may be measured directly from the diagram. After the field is completely drilled a considerable quantity of oil will still remain in the ground and the field will continue to produce at a constantly decreasing rate. The rate of decrease may, however, be estimated fairly well, for it is unaffected by the flush production of new wells.

The most satisfactory method of making this estimate is to choose some small area containing a number of fairly old wells, preferably one in which all the wells were drilled at about the same time, and to plot the production per unit of time of this group of wells after the date at which the last well was completed. The resulting curve may be taken as typical of the last period of the life of the average well in the field and it may be applied directly to the curve *ABCD* at the point *D*, which represents the time at which the field is completely drilled.

It may so happen that the field has produced a constantly decreasing quantity of oil since almost the first year of its life and that it is not possible to find two dates far enough apart at which the total production was the same. It may be possible, however, that for a considerable time the decrease in production was fairly constant. If so, a calculation similar to that required in the preceding method may be made, with the difference that drilling is theoretically continued at a rate sufficient to maintain not a constant production but a regular decrease similar to that which takes place during the period chosen. Then, in a manner like that just described, the date at which the field would theoretically be completely drilled may be calculated and the production up to this time estimated. The oil remaining in the field after the completion of drilling could then, as before, be estimated by assuming that the rate of decrease of production would be like that shown by a typical group of old wells.

An application of this method is shown in Fig. 5. Here the shaded area below the line *ABCF* represents

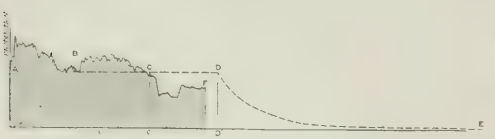

FIG. 4—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME ASSUMING THAT DRILLING MAINTAINS PRODUCTION OF CONSTANT FIGURE

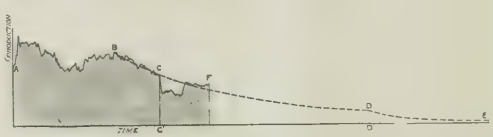

FIG. 5—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME, ASSUMING THAT DRILLING MAINTAINS PRODUCTION AT A UNIFORMLY DECREASING RATE

the volume of oil produced to date from the field. On the curve *ABCF* a section *BC* is chosen during which the decrease in production is fairly constant; the number of new wells drilled during this time is ascertained and, on the assumption that this rate of drilling will be continued from the time represented by point *C* until the field is completely drilled, the time at which the field will be completely drilled is calculated. This time is represented on the diagram by point *D*. The quantity of oil that will be produced between the time represented by point *C* and the time at which the field is completely drilled is represented by the area inclosed by the lines *CD*, *DD'*, *D'C'*, *C'C*. The oil that is contained in the field after drilling has been completed is represented by the area lying below the line *DE*.

In this method, as in the preceding one, the assumption that if new wells are drilled after the time represented by the point *C* at the same rate as they had been drilled during the period represented by the line *BC*, production would decrease at the rate at which it decreased during the line *BC*, is not quite correct. Because of the smaller initial production of wells drilled late in the life of the field, the number of wells necessary to maintain this rate of decrease in production of the field will gradually increase as the field is drilled up. A correction similar to that suggested in the method just described may be made here.

METHOD USING FIGURES SHOWING FIELD PRODUCTION EXPRESSED IN TERMS OF PRODUCTION PER WELL PER UNIT OF TIME

During the first few years of the life of a field, drilling is usually so actively carried on that the quantity of oil produced in the field as a whole during a given unit of time is constantly increasing. It is obviously impossible to apply either of the methods just described to this early period in the life of a field, for they are applicable only to a period when the field production per unit of time is decreasing. For many fields, however, a fairly satisfactory estimate may be made by expressing the production of the field per unit of time in terms of the production per well per unit of time, for although the production of oil obtained during a given length of time from the field as a whole is increasing, the production of the average well during equal intervals of time is the same or is decreasing. This method of estimating the petroleum reserves is not so accurate as either

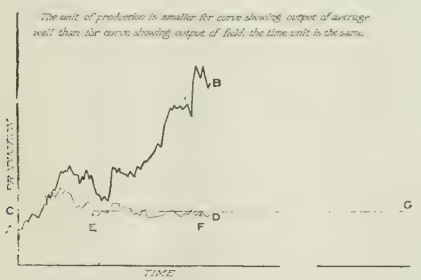
The unit of production is smaller for curve showing output of average well than for curve showing output of field, the time unit is the same.
B
C
E
F
D
G
TIME

FIG. 6—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING PRODUCTION PER WELL PER UNIT TIME, ASSUMING THAT DRILLING MAINTAINS PRODUCTION OF AVERAGE WELL AT CONSTANT FIGURE

of the preceding methods, because it is based upon fewer data. It should not be used, therefore, if either of the other methods is applicable.

Fig. 6 shows the application of this method. The production of the field is represented by the line *AB*. This curve shows a constantly increasing value for the production of the field during a unit of time, so that the methods represented by Figs. 4 and 5 are not applicable. The production per well per unit of time is therefore determined, and the curve *CD*, showing these values, is plotted. On the curve *CD* the points *E* and *F* are chosen as representing dates at which the production of the average well—the production per well per unit of time—is the same. The rate at which new wells were drilled during the time *EF* is ascertained and, as before, the length of time necessary to drill the field completely is determined, it being assumed that drilling will be continued at a rate that will maintain the production of the average well at a constant figure—a figure equal to that of the average well at the dates represented by points *E* and *F*. A first approximation of this date at which the field would be completely drilled may be obtained by assuming that production would be maintained at a constant figure if drilling be carried on after the date represented by point *F* at the same rate as it had been carried on during the period represented by the line *EF*. To be accurate, this assumption as to the rate of drilling after the time represented by point *F* should be corrected to take into account the smaller initial output of the wells that are drilled late in the life of the field. The time at which the field would be completely drilled is represented on the diagram (Fig. 6) by the point *G*. Then if

a = the number of wells producing at *E*—the first date.

b = the number of new wells drilled during a unit of time in the period between *E* and *F*—the two dates chosen.

c = production of the average well in a unit of time during the period *EF*.

d = the number of wells necessary to drill the field completely. (This number may be estimated from a knowledge of the geology of the field and of the field practice in spacing wells.)

S = the total amount of oil that would be produced between dates *E* and *G*.

And assuming that new wells are drilled after the time represented by the point *F* at the same rate as they had been drilled during the period represented by the line *EF*, the total quantity of oil produced by the field from the date *E* until the field has been completely drilled would be given by the formula:

$$S = ac + (a + b)c + (a + 2b)c + (a + 3b)c + \ldots + dc = \tfrac{1}{2}n\,(ac + dc),$$

where n = the number of terms in the series.

But:

$$n = \frac{d - a}{b} + 1$$

therefore:

$$S = \frac{d - a}{2b}\,(a + d)c.$$

The total quantity of oil produced before the time represented by *E* should be a matter of record. The oil remaining in the field after it had been completely drilled under the conditions stated may be estimated as in the two methods just described by assuming that the

rate of decrease in production will be the same for the field as it is for a small group of old wells.

If the smaller initial production of the wells drilled late in the life of the field is considered and the rate of drilling of new wells corrected to show this factor, the formula given above will not apply. The curve shown in Fig. 6 may, however, be projected in a manner similar to that in which the curve in Fig. 4 was projected. This curve will show the total amount of oil that the average well will produce, from which the total reserve in the field may be calculated.

Should the field production be increasing, but the production of the average well decreasing, the size of the available reserve may be estimated by a method similar to that shown in Fig. 5, but with the difference that the production figures plotted express the production of the average well, and not of the field as a whole.

PROBABLE DEGREE OF ACCURACY OF ESTIMATES

All the methods of estimating petroleum reserves described above involve the consideration of facts that, in the very nature of things, cannot be determined precisely, and the results obtained, therefore, cannot be precisely accurate. The results obtained by the methods that take into account the greater number of the variable factors are probably the more accurate. The writer believes that the methods he used in estimating the reserves in California express correctly the order of magnitude of the reserve, but he would not claim for them greater accuracy than that.

The Design of Modern Coking Plants*

By E. M. Myers

It is highly important that the site chosen should be such that efficient drainage can be installed with comparative ease. For these reasons slightly sloping ground should be chosen, and the sewers and drains constructed to pass a quantity of water at least 50 per cent greater than the maximum amount estimated.

If a coal washery is necessary it should be placed as close to the mine openings as economically possible, and certainly separate from the coking plant.

Effective provision should be made for dealing with the large volume of dust produced at the surface plants, not only because such practice would save thousands of tons of valuable fuel, in the aggregate, but at the same time this would obviate a great nuisance.

Designers of elevators nearly always lose sight of the fact that some day it would be necessary to repair them, apart from the fact that it is always necessary to inspect them. If an elevator was so constructed that it is impossible for a man to conveniently climb up and down the buckets there will always be trouble. It is important that the washery should have a capacity well in advance of the demands of the coke ovens, so that it would not be necessary to work continuously, thus giving ample time each day for repairs and overhauling. The bunkers must be large enough to hold sufficient supply to enable the ovens to be worked for at least thirty-six hours after the supply to the bins had been cut off.

The coal washer should be under the direct supervision of the coke-oven manager. The quality of the washed slack is so important, both from the point of view of the resulting coke and the yield of by-products, that it is imperative the coke-oven manager should be able to control that quality.

Apart from the peculiarities of the coal to be used, the important features that ought to govern the selection of the type of oven are (1) simple and complete control of the heating of the walls, so that the temperature remains constant throughout as nearly as possible; (2) all those parts of the ovens connected with the working of the gas and air control must be easily accessible, with a minimum of discomfort; and (3) the oven is to be so designed that the heating arrangements and the flues can be easily inspected. If the regenerative type is chosen, then the regenerators should be so efficient that the amount of gas required for the heating of the ovens is reduced to the lowest possible minimum, so as to insure the greatest possible quantity of surplus gas. The air supply must be capable of simple adjustment, so that complete combustion can be easily obtained and a minimum of time required for carbonization. Finally, the construction of the ovens must be sound—a substantial foundation must be provided—and the ovens should be built in small units. Batteries of thirty are certainly easier to control, and in a large plant, could be more easily laid off for extensive repairs than could big batteries. The flues should be so arranged that the crown of the oven remains comparatively cold, to avoid destruction of valuable by-products; and the bricks used for building the oven chamber and flues should be of high-class material, capable of withstanding, not only the high temperature, but the stresses and pressures to which they are subjected. The actual building of the oven walls must be done in such a manner that all possibility of leakage from flue to oven is reduced to the lowest possible minimum, and the discharging end must be at least 2 in. wider than the charging end.

The question as to whether regenerative or waste-heat ovens are to be erected must be decided by local circumstances, which determine the most economical disposal of the surplus gas or waste heat. Since coke oven gas is coming more and more in domestic demand, the greater first cost of the regenerative type of oven should be carefully discounted.

Three systems of by-product recovery—direct, semi-direct and indirect—can be made to yield excellent results with care, but if the characteristics of the coal were carefully considered before the type of recovery process was decided, a great deal of needless worry could be avoided. Salty coals should not be dealt with by the direct method, and where coals of this kind had to be used the semi-direct system should be adopted. In fact, future plants should be constructed on either the semi-direct or direct systems, as it certainly could not be held that the indirect method was conducive to small ammonia losses.

It has always been held by blast-furnace men that a dense hard coke capable of withstanding a great burden is best for blast-furnace coke, and it has also been held that coke produced from compressed coal is capable of satisfying this crushing effect in the furnace much better than that produced from uncompressed coal. Although it can be admitted that compressed charges yield denser coke than uncompressed, it cannot be conceded that better results are obtained in the blast-furnace by its use. Compressed charges are always liable to break before getting them into the retort, and their successful

*An abstract of a paper read before the Coke Oven Managers' Association (British) on June 30, 1917.

use depends on (1) the moisture in the slack, (2) the fineness of the slack, (3) the ability of the man in charge of the machine, and (4) the condition of the oven walls. On the other hand, these points do not affect the success of the top-charging method coupled with some mechanical leveling apparatus. Then, again, any system of mechanical charging with compressed charges leaves a greater space between the top of the charge and the crown of the oven than does the mechanical leveler, and although the amount of coal charged per oven must be less in the case of top charges, the carbonizing period is likewise shorter.

If more attention was paid to the type of door used a great deal of time and worry would be saved. What is required is some provision to enable the door to be fastened in its place without resorting to the use of daub or luting to insure its being gas-tight. Mechanical handling of the oven doors should be provided wherever possible.

In regard to water, it might be accepted that 1¼ tons of water per ton of coke produced per day is sufficient for all purposes—condensing, coke quenching, scrubbing, boilers, etc. On large plants it would be found economical to erect a water-cooling tower of sufficient capacity for condensing purposes, provided the works are not situated close to unlimited supplies of good cold water.

Where it was decided to include a tar plant the question of pitch bays is important. These should be large enough to allow a quick and efficient cooling of the pitch, and so placed that the pitch could easily be loaded. The continuous tar distillation system is the best one to adopt, as repairs and renewals are much more easily carried out than in large intermittent plants.

The building for the exhausting and pumping plant should be provided with an overhead traveling crane, which will pay for itself many times over when the question of repairs and renewals comes to be faced. In fact, all the buildings containing plant that has to be cleaned or repaired should be designed in such a way that overhead lifting arrangements are permanently installed. The construction of adequate and sanitary change houses is very much to be recommended.

Shelton, England

Electrode Cooling

By Haakon Styri,
Metallurgist, Hussey-Binns Steel Co.

A simple arrangement of the water cooling on electrodes introduced by the writer, some time ago, on the Heroult furnace at the Hussey-Binns Steel Co. plant, has worked very satisfactorily. The accompanying sketch, showing the arrangement as applied to the middle electrode, gives the principle.

The cooling water comes through the armored hose (1) to distributing box (2), fastened on the outside of the columns for the electrode holders. Only three pipes go out from the distributing box—one to each electrode, and each of which is furnished with a regulating valve. Where the pipe passes the roof ring a piece of rubber hose (3) is inserted for insulation and connected with a union (4) to the pipe which goes to the cooling ring. The return pipe from the cooling ring is connected with a union (5) to the rubber hose (6), which is sufficiently long to allow for total electrode movement and some surplus to prevent kink. This rubber hose is again, by means of union (7), fastened to the pipe leading to the electrode holder, and the return pipe from this is, by means of union (8) and rubber hose (9), connected to the downfall pipe (10), which is fastened to the electrode carriage. From the pipe (10) the armored rubber hose (11) leads to the common waste-water box.

The advantage of the arrangement is that all pipes on the furnace can be very easily drained in case of cold weather, when the furnace is out of operation,

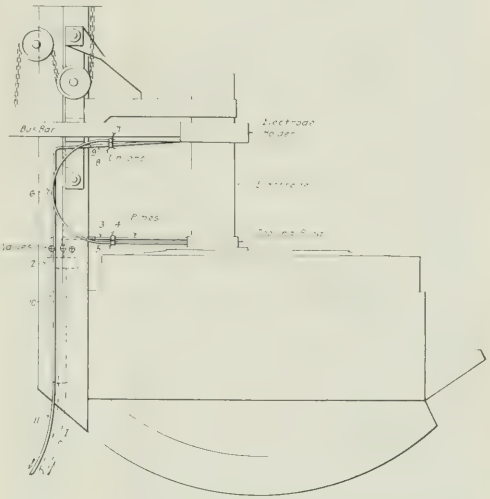

FIG. 1—ARRANGEMENT FOR WATER COOLING

and freezing of the water is to be feared. Disconnection of the unions of the armored feed hose (1) and waste hose (11) will give complete drainage.

In case muddy river water is used for cooling it is advisable not to thread the ends of the pipes on which the hose from the cooling rings are fastened. This avoids danger when, after a clogging up, steam will be suddenly developed in the cooling ring, causing the hose to blow off.

The further advantage is that very little rubber hose is used, and only three valves are to be operated by the furnaceman.

Pittsburgh, Pa

New Dyestuff Journal.—The *Color Trade Journal* is the title of a new monthly journal, the first number of which appeared in August. The Journal will be devoted to the interests of the manufacturer and user of dyestuffs, and is published by the Color Trade Journal, Inc., 200 Fifth Avenue, New York. The editor, Dr. J. Merritt Matthews, needs no introduction to chemists in this section, as he is a well-known expert on dyestuffs and the author of several books and many technical articles on their application. C. W. Butterworth is managing editor and Eugene C. Mayer business manager. The publishers are to be congratulated on the appearance and material of the first issue. The Journal should be of great assistance in bringing the needs of the users of dyestuffs before the manufacturers and in bringing about cordial relations between them, which is the best safeguard for our new American dyestuff industry.

The Utilization of Waste-Products and of Low Grade Fuels for Power Generation—II*

By John B. C. Kershaw, F.I.C.

THE USE OF COKE AND COKE-BREEZE.

The war has altered many old-established maxims in our industrial and economic life, and amongst the time-honored beliefs that have been thrown overboard is the idea that coke and coke-breeze are unsuitable fuels for steam generation.

The difficulties of burning coke or coke-breeze in the ordinary type of boiler furnace, provided only with natural chimney draft, had of course something to do with the existence of this idea. Every different type of fuel, however, requires special conditions for its complete combustion under steam-boilers. The fact that coke and coke-breeze could not be burned satisfactorily in furnaces designed and primarily intended for the combustion of bituminous coal was no proof that they could not be completely burned with high efficiencies, *under proper conditions*, namely, those suited for fuels high in ash and fixed carbon, but low in their percentage of volatile matter.

The more careful study of the problems of fuel combustion in recent years has shown that practically every variety and type of combustible material can be burned, and its heat value converted into the thermal energy of steam, provided, first, that the combustible matter exceeds 65 per cent; second, that the furnace is correctly designed and, third, that the air supply is properly distributed and proportioned to the needs of the fuel. Materials which have for many years been regarded as waste trade-products are now being impressed into the service of the steam-producer, and the combustion of coke and coke-breeze is in reality a much simpler problem than the burning of *"Towns' refuse"* or of *"Bagasse"* and other vegetable wastes, for power purposes.

The technical side of the problem is only one aspect of it. In the past, the relative price of coal and coke has also had much to do with the neglect of the latter as a fuel for steam-boilers. The war has led to a considerable increase in the demand and in the price paid for coal, while the production of coke has been enormously increased, owing to the great demand for benzol, toluol, and other valuable by-products. In many coal and coke producing districts, therefore, the price of coke and coke-breeze has remained steady or has actually fallen, while that of coal has increased, and the relative values of coal and coke have been altered in favor of the latter fuel. It is highly probable that this altered economic relationship will continue after the war is over, for the increase in the labor charges of mines and railways is likely to be permanent, and coal will remain at its present high level of cost for many years to come. The following data and information concerning the use of coke and coke-breeze for steam-raising should therefore prove of more than passing value, since the conditions which favor the cheaper fuel are likely to continue.

THE CHEMICAL CONSTITUTION AND CALORIFIC VALUE OF COKE AND COKE-BREEZE.

Coke represents the non-volatile portion of ordinary coal after it has been subjected to heat in the absence of air, and it may be regarded therefore as containing only the fixed carbon and the mineral matter, or ash, of the original fuel. Nearly all forms of coke contain a small amount of volatile matter, varying from 1.0 up to 5.0 per cent, the percentage being lowest in the hard cokes produced by high-temperature ovens for blast furnace work. The soft porous cokes obtained by low-temperature distillation contain on the other hand from 5 to 10 per cent of volatile matter, and do not come within the scope of the present article.

Coke-breeze represents the screenings from the lump coke after this has been drawn from the retorts and has been quenched by water. It contains as a general rule a higher percentage of ash and moisture than the lump coke from which it has been obtained.

From the steam-raiser's point of view, therefore, the chief impurities of these forms of fuel are the moisture and the ash.

THE MOISTURE IN COKE AND ITS EFFECT UPON COMBUSTION.

Both coke and coke-breeze contain considerable percentages of mechanically held moisture, due to their physical structure and to the drenching practice. Contracts for either form of fuel should therefore specify a limit of 6 per cent for the allowable amount of moisture. The disadvantage of using coke or coke-breeze with higher percentages than 6 per cent is that this water has all to be converted into steam and driven off before the coke can be ignited. Furthermore, since it escapes in the form of aqueous vapor with the waste-gases, it carries off a large amount of latent heat which cannot be recovered even in the economizers. Experimental steam-raising trials of coke and coke-breeze containing varying degrees of moisture, by the Buenos Ayres Tramway Power Station, proved that a 10 per cent rise in moisture caused a 24 per cent increase in the fuel bill.

THE ASH IN COKE.

The ash in coke and coke-breeze varies greatly, since it represents all the mineral matter of the original fuel in a more concentrated form. If this original fuel has been a bituminous slack or coal of poor quality, the ash percentage in the coke or coke-breeze may rise to 20 or even 30 per cent. Lump coke of good quality however should not contain more than 6 to 10 per cent of ash, and contracts should have the latter limit inserted as the maximum allowable percentage.

Coke-breeze will naturally contain a higher percentage of ash, and up to 20 per cent may be expected to occur in the deliveries of this form of fuel. Should this limit be exceeded, the breeze should be rejected, for a fuel containing over 20 per cent ash and 10 per cent moisture will not yield much heat of value for power purposes when burned under steam-boilers.

The following are typical analyses of coke and coke-breeze, with figures for the gross and net calorific values, as determined by laboratory methods. It may be noted here that the calorimeter determinations of coke and coke-breeze will always yield considerably higher values than can be obtained in practice, owing to the fact that they are tested in the dry state. The necessary deduction that must be made for the heat

*The second of a series; the first paper on "Town's Refuse" appeared in our issue of Feb. 15, 1917; Vol. XVI, p. 229.

lost in drying the fuel is shown in column 4 of Table I, and is found by calculating the thermal units required to convert the water contained in one pound of the fuel into steam.

TABLE I—TESTS OF COKE-BREEZE
(By J. B. C. Kershaw)

	Per Cent Moisture	Per Cent Ash	Per Cent Volatile	Losses Through Moisture, B.t.u.	Calorific Value, B.t.u.	
					Gross	Net
No. 1.....	19.43	22.16	5.07	2,468	11,521	9,053
No. 2.....	16.92	21.16	2.50	1,751	11,494	9,743
No. 3.....	12.50	26.62	5.63	1,493	11,188	9,695

TABLE II—TESTS OF GAS-COKE
(Poole)

	Moisture, Per Cent	Ash, Per Cent	Volatile, Per Cent	Calorific Value in B.t.u. (Gross)
No. 1.....	3.73	6.41	0.93	12,687
No. 2.....	1.24	11.60	1.34	12,548
No. 3.....	0.90	9.62	1.76	12,599

THE CONDITIONS OF COMBUSTION, AND FORMS OF FURNACE GRATE REQUIRED.

The above analyses show that coke and coke-breeze contain larger amounts of moisture and ash than ordinary coal, and that the percentage of fixed carbon in the combustible portion of the fuel approaches that of anthracite. The conditions required for the successful combustion and utilization of the heat generated by coke and coke-breeze are therefore similar to those obtaining with anthracite fuel, and are, first, artificial or forced draft; second, close approximation of the heat absorbing surface to the glowing mass of fuel; and third, facilities for dealing economically with the large amounts of clinker and ash. As the volume of hydrocarbon gas given off by the fuel is comparatively small, the need for large combustion spaces and for the supply of secondary air is non-existent, the conversion of the carbon into carbon-dioxide gas occurring chiefly on the bars of the grate.

For these reasons the marine, Lancashire, or Cornish type of boiler is more suitable than the water-tube boiler for burning coke and coke-breeze, and very little adaptation of the internally fired boiler-furnace is required to fit it for use with the new fuel. If it is desired to burn the coke or breeze on some form of mechanical stoker under a water-tube boiler, it is necessary to mix it with ordinary fuel. In the last section of this article some figures are given showing the economy of this method of burning. The maximum proportion of coke which can be burned in this way is 50 per cent, and where it is necessary or desirable to exceed this proportion, the grate and conditions of draft must be altered to meet the new requirements.

For use either alone or mixed with bituminous coal, the coke must be of small lump size (say 1 to 1½ in. cubes) and a fire-bed of not more than six to eight inches in thickness should be maintained. When burning a mixture of coal and coke, or coal and breeze, it is very important that the fuel should be well mixed, and in the case of lump fuel, that the pieces should be similar in size. A method of burning the mixed fuels on chain-grate stokers, which is stated to have given good results, is to fit an additional hopper to the front of the stoker by means of which a layer of small crushed coke or breeze is fed on the chain-grate, before the ordinary fuel comes down upon it from the hopper above. The grate then travels forward with two layers of fuel upon it, the coke below and the bituminous above. The proportionate depth of these two layers can be varied by altering the relative speeds at which the two hoppers deliver their fuel to the grate.

Since coke is not readily ignited except by contact with glowing carbon, the fires must be started with bituminous coal, and when the volatile gases have distilled off and only red-hot embers remain on the grate bars, the firing with coke can commence.

Since practically no hydrocarbon gases are evolved from coke on heating, the air admission may be entirely from below the grate, and all openings and grids by which secondary air has been admitted above the fuel or behind the bridge should be closed. As coke occupies twice the space of ordinary coal, weight for weight, it follows that twice the bulk of coke must be burned on the same grate-area in order to obtain the same evaporative effect. This rate of combustion demands in most cases *closed ashpits and forced draft.*

If breeze and lump coke are being burned together it is well to have transverse bars instead of longitudinal ones, since these check the tendency of the fine ash to be carried away into the side-flues of the boiler. When transverse bars are used in the furnace, however, they must be bedded in some refractory cement at the ends where they approach the boiler-plates—otherwise "blow-pipe" action may occur at these points, and the plates suffer injury.

As regards the rate of combustion possible with coke: When a good natural chimney draft exists, the rate of burning can be raised to 15 or 20 lb. per sq. ft. of grate area per hour. With forced-draft, the rate can be increased to 30 lb. per sq. ft. per hour. A grate area of 33 sq. ft. (that of the ordinary 7 ft. diameter Lancashire boiler) will thus suffice to burn 990 lb. of coke per hour. Assuming that 8 lb. of water are evaporated per pound of coke, the evaporative effect will be 7920 lb. of water per hour. Since the greater part of the evaporative effect under these conditions is obtained by radiation, i. e., by the heat transmitted directly through the boiler-plates in the neighborhood of the fire-box, it follows that in coke-fired Lancashire or marine type boilers, *special attention must be directed toward keeping these plates free from scale and grease.* The feed-water must therefore be regularly examined for scale-forming salts and organic impurities.

When coke-breeze or coke-ashes containing over 30 per cent of incombustible matter are to be burned alone, some form of external furnace of the Dutch-oven type becomes necessary for their complete combustion, and in this case the advantages offered by the internal fire-boxes of the marine and Lancashire type of boiler are lost. Forced-draft will still be necessary to burn the fuel, and the radiant heat from the furnace can be utilized by means of chequer work and hollow walls for pre-heating the air. The heat of the gases issuing from this type of furnace can be best utilized in the water-tube type of boiler. Underfeed stokers are sometimes used with this type of furnace, but as the proportion of ash in the fuel rises, the difficulty of obtaining anything like complete combustion of the carbonaceous matter with mechanical stokers increases.

With any type of hand-fired furnace, great care is required to avoid accidents from back-firing or from explosions in the boiler flues, due to the accumulation

of carbon monoxide gas when the draft is cut off for cleaning and clinkering the fires. In order to minimize the danger from these causes, the following precautions may be taken:

First, swivel-dampers should be substituted for vertical drop-dampers in the side-flues. These should be worked with link-rods and a lever from the boiler-front. The side-flues should be inspected and cleaned frequently, to prevent accumulations of flue-dust or soot at the foot of the swivel-dampers.

Second, an excessive depth of fuel-bed is contributory to the accumulation of explosive gases and a fire-bed of 10 in. should never be exceeded.

Third, the safety-plugs inserted in the ends of the flue-walls should not be blocked by heavy iron tools or implements, but should have a free path of egress should explosions occur in the flues.

Since the local temperatures in furnaces fired entirely with coke or breeze under forced draft are much higher than in ordinary coal-fired furnaces, some trouble also may be experienced by burning and failure of the fire-bars. If this occurs the admission of steam to the ash-pit under the grates may be the only practical remedy, unless some system of water-cooling be adopted. If steam-jets are used for creating the draft, this danger is already provided for—but where fan-draft is employed an emergency steam-pipe to each closed ash-pit is desirable.

The correct regulation of the air supply to coke-fired boilers is not more difficult than that to coal-fired, but there is no smoke to warn the firemen when the air supply is deficient. With both types of fuel constant testing of the waste-gases is an essential of good management and of high efficiencies. Under scientific management, however, it is possible to obtain a higher average percentage of CO_2 in the waste gases with coke than with ordinary bituminous coal. This means that the chimney losses are reduced considerably, and that a higher efficiency is obtained from the fuel. A clear chimney gas is a considerable advantage, especially in those industrial centers where the smoke-inspector is active, for under no conditions of neglect can coke-fired boilers produce a black smoke.

ACTUAL RESULTS OBTAINED WITH COKE AND COKE-BREEZE FIRING

Test I.—For some months a small electrical supply station in the north of England has been successfully employing a mixture of slack and coke-breeze in equal proportions upon a chain-grate stoker, with a water-tube boiler. The slack costs $4 per ton at the generating station, while coke-breeze from the local gas works can be delivered at a cost of only $1.50 per ton. The average price of the mixed fuel per ton as charged into the hoppers of the chain-grate stoker is therefore $2.75 per ton. The day load at this station is taken by a Diesel oil engine, and the boiler is only worked in the evening. The results obtained with the two fuels are:

	Slack Alone	Mixed Fuel
Date of test	Nov. 13, 1914	Oct. 10, 1916
Duration of test	4 hours	4 hours
Calorific value of dry fuel in B.t.u.	13,168	12,178
Price per ton in the works	$4.00	$2.75
Moisture in fuel	7.68 per cent	10.09 per cent
Lb. of fuel used	4,027 lb.	4,704 lb.
Lb. of water evaporated	31,531 lb.	30,800 lb.
Water evaporated per lb. fuel	7.83 lb.	6.55 lb.
Draft	½ inch	½ inch
Cost of evaporating 1,000 gallons of water	$2.26	$1.86

This shows a saving in fuel costs of 40 cents per 1000 gal. of water evaporated, or 18 per cent in favor of the mixed fuel. It is noteworthy that the draft was the same in both tests, and that the total output of steam was only slightly less with the coke-breeze mixture.

Test 2.—The engineers of the Buenos Ayres Tramway Power Station have made a large scale trial of gas-coke and coke-breeze for firing their boilers, and have allowed Messrs. Beatty and Smith to publish the results obtained, in the paper named below.[1]

Ten thousand tons of gas coke were burned during the trial, containing on the average 13.5 per cent ash and 13 per cent moisture. The following are the average results obtained from the fuel:

Water evaporated per lb. of fuel	5.7 lb.
Water evaporated per lb. of fuel from and at 212 deg. F	6.71 lb.
Fuel used per kw.-hr	3.675 lb.
Boiler efficiency	57.6 %

As the cost of the gas coke is not given, the comparative costs of firing with coal and coke cannot be calculated, and in this respect the results are not so useful as those given in the preceding table. The best results at Buenos Ayres were obtained with a large delivery of coke which contained only 6 per cent moisture. This gave an evaporative effect of 7.9 lb. water (from and at 212 deg. Fahr.) per pound of fuel, during trials extending over one month, corresponding to a boiler efficiency of 62 per cent.

When the moisture in the coke rose to 20 per cent, the boiler efficiency fell away to 55.6 per cent. As already stated, a 10 per cent rise in the moisture content of the coke caused a 24 per cent increase in the weight of fuel used, for not only had more coke to be handled to obtain the same amount of combustible, but a greater portion of the heat generated was employed in evaporating the water.

Test 3.—The chief engineer of the London Coke Committee, in a paper read before the London District Gas Association, has given the results of comparative tests made when firing coal and gas coke in two Cornish boilers in February of the past year.[2]

The tests were made in London, which accounts for the fact that the relative prices of coal and coke-breeze are much higher than in Test I, and that the saving effected by the use of the cheaper fuel rises to 34 per cent. The substitution of forced draft for natural draft, and the maintenance of a high CO_2 average, would no doubt account for the marked increase in the efficiency of the boilers.

The author of the paper from which this data was obtained exhibited models of the steam-jet draft apparatus used in these tests, and stated that the steam used for the jets did not exceed 3 per cent of that generated. He emphasized also the fact that the heat generated by coke is chiefly utilized as radiant heat in the boiler, and that, for this reason, the fire-box heating-surface was the chief factor in steam production.

The tendency on American railways, where mechanically stoked coke-breeze was being employed for steaming purposes was, he stated, to increase the area of the fire-box heating-surface and to diminish that of the tubes. Reliable tests had proved that 1 sq. ft. of fire-box heating-surface, when exposed to direct radiation

[1] "Electrical Review" (New York), April 14, 1916.

[2] "The Gas World," April 1, 1916.

FUEL TEST, FEBRUARY, 1916

Fuel Tested	Bituminous Coal	Gas-Coke	Gas-Coke and Coke Breeze
System of Draft	Natural Draft	Blowers	Blowers
Cost per ton delivered	$6 00	$6 00	$4 20
Duration of trial, hours	6 50	7 25	7.66
Total grate-area, sq. ft	58	58	58
Amount of fuel used, lb.	6,720	7,500	4,200 coke + 4,200 breeze
Fuel burned per sq. ft. of grate area per hr., lb.	16 1	16 1	17 1
Water evaporated, lb. actual	45,950	65,600	39,200
Water from and at 212 deg. F. per lb. of fuel	7 74	9.80	7.99
Cost per 1,000 gals. evaporated	$3 48	$2 80	$2.26
Per cent CO_2 in gas	Not taken	16 0	16.25
Net efficiency of plant, per cent	70 72	85	80.9
Financial saving effected by adopting coke-fuel and forced-draft, per cent.		19	34

from burning coke, will evaporate five times as much water as 1 sq. ft. of tube-surface.

Test 4.—German tests with coke and coke-breeze. In the year 1910 a commission was appointed by one of the leading German societies of mining engineers to investigate the utilization of low grade fuels, and the reports issued by this commission have been published from time to time in the German mining journal *Glückauf*. Some of the figures and results obtained by this commission will now be quoted:

Two evaporative tests were carried out on Aug. 2, and 3, 1910, at the Consolidation mine, near Dortmund with the "*Praesto*" and "*Kridlo*" systems of firing coke-breeze or ashes from the quenching-plate containing 24 per cent ash, 15 per cent moisture, and 4.5 per cent volatile matter. The boiler with which this test was made was one of a battery of six "Alban" type of water-tube boilers, with a grate surface of 32 square feet, and a heating surface of 1393 sq. ft. The fuel used cost only 40 cents per ton. Each test lasted 8 hours, and after deducting the steam used for the steam jets, the tests showed that the evaporation per pound of fuel had been 3.03 lb. in one case and 3.3 lb. in the other. These results show, on comparison with those obtained with a similar fuel burned under the same conditions under a Lancashire boiler, that the water-tube type of boiler is not so suitable as the other for use with a fuel so low in volatile matter, thus confirming what was said in the introduction on this subject.

Further tests made with a similar fuel, and the same systems of firing, were made on Aug. 25, 26 and 31, 1910, at an installation of Lancashire boilers located at the Ludwig mine, Westphalia. The coke-breeze in this case contained 10 per cent volatile matter. The grate area was 31 sq. ft., the heating surface was 1003 sq. ft., while the forced draft was obtained from an electrically-driven fan. The results of three tests showed that 5.2, 4.90 and 4.64 lb. respectively of water had been evaporated per pound of fuel burned, and that the cost of evaporating, after allowing for all running and fixed charges, had been from 78 to 82 cents per 1000 gal. of water.

Some figures obtained by the same commission at the Achenbach mine with coke and coke-breeze burned by aid of the "Wilton" apparatus for producing forced-draft are as follows:

Three steam-jets were used to force the air into the furnace, and a special form of distributing box was employed to carry the air up through the furnace bars into the bed of burning fuel. The steam-jets were not employed continuously, but were closed for about one-fourth of the time when the fires were being cleaned, or fresh fuel was being charged. A separate test was made of the steam required to produce the blast, by allowing a similar steam-jet to blow through a cooling-worm, and by weighing the water condensed. This amounted to 164 lb. per hour for the first test, and to 125 lb. per hour for the second test, and represented about 3 per cent of the steam production of the boiler. Comparative tests were made in September and November, 1912, with the natural draft and forced draft systems, and the following are the more important average figures obtained in the four trials, the test in each case lasting eight hours:

	Natural Draft	Forced Draft
Cost of fuel per ton	38 cents	38 cents
Water evaporated per lb. of fuel	4.08 lb.	4.99 lb.
Water evaporated per sq. ft. of grate area per hour	20.50 lb.	36.70 lb.
Cost of evaporating 1,000 gals. of water	88 cents	75 cents
Boiler efficiency	52.4%	65.8%

The special feature of these German tests is the very low cost of the fuel used, and consequently the very economical figure for the cost of evaporating 1000 gal. of water, namely 75 to 88 cents, as compared with $1.86, the lowest cost for the English returns. When comparing the figures, however, we must note that the German tests were made at the mines or coke-ovens, *with fuel which would have otherwise been wasted*, and that the charge made for it to the boilers was merely a nominal one.

With coke-breeze at the same cost, the English figures for the cost of evaporating 1000 gal. of water would prove equally striking.

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Synopsis of Recent Metallurgical and Chemical Literature

Cellulose

Cellulose and Related Products.—In the *Journal of the Society of Chemical Industry* for May 31, 1917, is given an abstract of a lecture by C. F. CROSS, delivered at the Royal Institution on March 2, 1917. The lecture covered the chemical and industrial developments of the cellulose and allied industries from 1866 to 1916. The "positive" chemical technology of cellulose is necessarily based upon its reactivity, and the industries which exploit the reaction changes of cellulose are of widely divergent character; those of Group A are based upon reactions of decomposition, those of Group B are based upon the properties of synthetical derivatives.

Of Group A, the resolution of cellulose into sugar (dextrose) by acid hydrolysis is the basis (1) of a process for the preparation of industrial (ethyl) alcohol from wood, and more economically from wood wastes. According to our latest information, the technical difficulties presented by this apparently simple process have been so far overcome that the alcohol is produced on the large scale at a cost of 2½ d. per gallon, exclusive of the small cost of the waste wood material. Under these most favorable conditions, however, the yield of alcohol is only 5 per cent of the weight of the wood substance, or say 8 per cent of its cellulose content, leaving therefore a very large item of final waste to the debit account of the chemist.

(2) Sawdust, or other wood waste, fused—*i.e.*, heated at high temperatures—with the caustic alkalies is destructively oxidized, and the main product of the oxidation is oxalic acid; this process is in effect the main source of the acid, as an industrial product.

(3) Waste wood subjected to destructive distillation in closed retorts is resolved into gaseous and volatile liquid products, with a solid residue of charcoal or pseudo-carbon. The liquid products contain acetic acid, acetone, and methyl alcohol as chief constituents, and have been the main source of supply of these chemical individuals, which, as reagents especially, are indispensable in modern chemical industry.

In this direction, however, cellulose material and its wasteful treatment by destructive distillation are being supplanted by a direct and controlled synthesis from calcium carbide, acetylene being quantitatively transformed into acetaldehyde, and this into acetic acid. In this new industry the pioneers in this country are the British Cellulose and Chemical Manufacturing Company, Spondon, Derby.

(4) Cellulose treated in full contact with oxygen is burned with the familiar flame combustion; but from all the natural structural forms there is a residue of inorganic matter (ash) which when present in impotrant proportion preserves the general structural details of the original. This intimate combination of cellulose with inorganic matter is a characteristic property of colloids of which cellulose is the prototype. It is the basis of innumerable processes incidental to the dyeing and coloring of cellulose fabrics and tissues. But the production of a combustion skeleton for utilization as an industrial product is a modern and noteworthy realization of a primary cellulose quality "strong even in death."

The familiar incandescent gas mantle is the skeleton of a textile material impregnated as such, or as we may say, "in the flesh," with colloidal thorium and cerium oxides, and afterwards cremated.

Of the cellulose industries of Group B, those (1) based on the nitric esters are of preponderating importance, for they include the production of the modern military explosives and they connote developments in pure and applied science peculiarly characteristic of the age. Cellulose nitrate not only fulfills the ideal of chemical effect, *i.e.*, total conversion of solid into gaseous matter, at maximum increase of volume (or pressure), further increased by the temperature of combustion, but is a stable form of this high chemical potential, and further owing to its colloidal plastic properties can be molded into any desired form and is therefore able to meet the most exacting specification of ballistic requirements. There is no doubt that mankind is directly indebted for its "smokeless" powders and the basis of the vast developments of modern military power to the pioneer work of Alfred Nobel and his collaborators.

The lower degrees of "nitration" of cellulose are represented by products which are the basis of "celluloid," and the celluloid industries connote the production of a large number of familiar objects both useful and ornamental, and a progressively increased production from the date of the pioneer work of the American inventor, Hyatt (1869).

Celluloid realizes a very high order of plasticity, and it is this structural potentiality which enables it to maintain its industrial leadership in spite of its disadvantages of hgh inflammability frequently and tragically manifested.

(2) The analogues of the nitric esters are the acetic esters of cellulose derivatives, which are necessarily colloids with plastic capabilities, water-resistant as are the nitrates, and with a higher order of resistance to heat (unchanged at 200 deg. C.), and the ordinary inflammability of organic substances. Important uses of the cellulose acetates already established are: (*a*) in aeroplane construction, for treating to render taut and impermeable the textile fabric which constitutes the air-resistant surface of the wings; (*b*) in the form of film, as the "emulsion-film" support in photographic work, notably for the preparation of the continuous cinema picture; (*c*) for a varnish for metallic surfaces, and notably for electrical insulation and applications which depend upon exceptionally low inductive capacity.

In the above brief account of the cellulose nitrates and acetates there is the implicit suggestion of the production of artificial textile threads by drawing the solutions of these bodies through orifices of suitable form and dimensions such that after removal of the solvent liquid the re-solidified and structureless ester constitutes a cylnder of hyaline material of uniform diameter.

The industrial production of artificial threads, and notably of the "silk" or lustra cellulose, we owe to the pioneer enterprise and purposeful tenacity of a French technologist, H. de Chardonnet. But cellulose nitrate as *matière première* has many and obvious defects; hence the alternative plastic forms or derivatives of cellulose have progressively displaced the original industrial product, which had a brilliant career of success in the early years of this century.

There are three main rival processes of which the underlying principles are common. They are expressed in the stages or phases of the process:

(1) Cellulose is transformed by reaction into a synthetic derivative—dissolved as such to an 8 per cent solution (calculated as cellulose), filtered and continuously projected, or drawn through fine tubes or orifices, into a solidifying or setting medium.

(2) The thread as a unit filament (monofil, crin, crinole), or multiple group of twisted filaments (artificial silk), is a cellulose ester or other derivative, and is chemically treated to remove combined groups, or impurities as by-products of decomposing reactions; the thread substance is cellulose, reappearing as such after the cycle of changes.

The three cellulose derivatives on which these important industrial processes are based are: (1) The nitric esters; drawn or "spun," as ether-alcohol solution (Chardonnet process).

(2) The ammonia-soluble cellulose-hydrate-copper-hydroxide compounds (cuprammonium process).

(3) The xanthic or sulpho-carbonic ester, synthesized in two stages: (*a*) mercerization of the cellulose; (*b*) combination of the alkali cellulose with carbon bisulphide, and solution of the product in water (viscose process).

Of these the viscose process is now predominant by reason of its advantages, technical and economic. It will be noted that the material "elements" of the industry are cellulose, common salt, carbon and sulphur, than which no simpler terms could be devised, even as *a priori* proposition.

Of other industrial applications of the Viscose

process, the production of transparent film in continuous length is a variation only of the process above described, the liquid viscose being drawn through a controlled adjustable slit of 1.5 m. width, into a setting solution or precipitant, which converts it at once into the solid state, but retaining 80 per cent of water. This hydrated product is purified by successive treatments, and is finally dehydrated and dried with a shrinkage of 33 per cent, the 1.5 m. of hydrated xanthate, as first precipitated, being reduced to a width of 1 m. in the finished cellulose film.

This is a noteworthy achievement in chemical engineering, and is entirely due to the inventive presistence of the personnel of the Société Française de la Viscose, especially to MM L. Naudin and J. E. Brandenberger. It is a pleasant duty to recognize technical pioneer work of so high an order.

In addition to these main applications there are many other uses of the reactions involved in the viscose cycle. Thus "mercerization" of cellulose is an application of the interaction of cellulose (textiles) and caustic soda, to produce luster effects and finishes upon cotton goods. The structural changes of yarns and cloths determined by these reactions were investigated by John Mercer at a period which long antedates our half-century of progress. To Mercer's anticipations there succeeded a long incubation period. A few discoveries of minor import in this field then revived interest in the major product; the alkali cellulose of the Viscose cycle and "mercerized goods" became a textile market of first note and importance.

Copper, Lead and Zinc

Electric Smelting of Copper Ores.—W. DEWAR, in the June, 1917, number of the *Mining Magazine*, describes the results of two tests when smelting highly silicious oxidized copper ores in the electric furnace. These tests were run at the works of Messrs. Keller, Leleux & Company, at Livet, Isere, France. The furnace used was of the resistance type consuming 600 to 700 kilowatts alternating current. The furnace had two tap-holes, one for the metal and one for the slag. The ore was crushed to pass a 1-in. ring; the flux was lime and the reducing agent was charcoal. The ore used contained 10.94 per cent CuO in the first test, and 12.10 per cent in the second. The summary of results is given in Table I:

In test No. 1 the voltage varied from 96 to 106, and the amperage from 2400 to 5500; in No. 2 the voltage variation was from 97 to 104 and the amperage 3500 to 6000.

The slags formed were bisilicates, the respective amounts formed per ton of ore smelted being 1.22 and 1.24 tons, and averaging 0.25 per cent and 0.3 per cent in copper. These slags compare favorably with those obtained in matte smelting and show a decided improvement over slags obtained in blast-furnace smelting of such ores; they were clean and flowed freely, usually solidifying without previously passing through a plastic state. The average running temperature was 1450 deg. C., as determined with a Wanner pyrometer.

With a suitable slag there is no difficulty in producing a good grade of black copper in the electric furnace. No metal was tapped in the first trial due to the fact that the tap-hole for metal was too high. In the second test three tappings were made 9 hours, 21 hours and 31 hours after starting. The analyses were as follows:

	1	2	3
Copper	75.96%	61.25%	57.74%
Iron	23.60%	34.75%	39.90%

Toward the end of the run, this metal was thrown back in the furnace and remelted with that remaining in the furnace, and then tapped off into specially designed molds in order to separate the metal into a high and a low grade product. It was found that segregation takes place at certain as yet undetermined limits, two segregates being obtained, one running 91 per cent copper and one 51 to 57.6 per cent copper.

Physical Chemistry

The Motion of Ions and Electrons Through Gases. by E. M. WELLISCH, University of Sydney, *Philosophical Magazine*, Sixth Series, No. 199, page 33. It has long been known that in air at very low pressures the current of negative electricity is due practically entirely to free electrons; at higher pressures, however, it is due to the motion of negative ions. If the ion at high gas pressure be conceived as a cluster of molecules, it would follow that as the pressure was reduced the average number of molecules in the cluster would decrease; as the pressure was still further reduced, and individual negative carrier would be for part of the time in the ionic state (say now as a single molecule) and for the remainder would exist as a free electron. Ultimately at very low pressures the carriers would be all free electrons. New experiments described in the paper show that while the law pk = constant (where k is the mobility of the ion, p the pressure of the gas) holds good to the lowest pressure for the positive ion, the negative carriers were found to consist of two distinct kinds, electrons and single-molecule ions, the former coming more and more into evidence as the pressure of the gas was reduced. The electrons travel freely through the gas without attaching themselves to molecules. When the ions were consid-

TABLE I—SUMMARY OF RESULTS. LONG TONS

Trial Number	Material Smelted in Furnace: Totals During Trial: Ore Mixture, Tons	Ore, Tons	Average per 24 Hours: Ore Mixture, Tons	Ore, Tons	Materials Used per Ton of Ore: Lime, Tons	Charcoal, Tons	Power Consumption: Per Ton Ore, Kw.-Hr.	Per Ton of Copper, Kw.-Hr.	Electrode Consumption: Per Ton of Ore, Kilos	Per Ton of Copper, Kilos	Copper: Recovered as Metal, per Cent	In Slag, per Cent	Unaccounted for, per Cent
1	27 12	17 9	14 95	9 84	0 199	0 047	1,122	14 025	12 40	155 00	91 48	5 0	3 52
2	69 38	43 4	15 15	9 52	0 519	0 016	1,028	11,719	5 53	63 04	91 10	5 6	4 74
	96 50	61 3											

ered apart from electrons all previously noted anomalies disappear, the velocity being expressible in the form

$$v = k_v \frac{x}{p}.$$

In the so-called permanent gases free electrons will therefore occur at all pressures, even if a very small relative number. In inert gases the negative carriers are almost entirely electrons even at atmospheric pressure, but in all instances a slight trace of impurity (especially oxygen) was sufficient to convert the carriers into ions. Inert gases and hydrogen are now regarded as being exceptional, not in their power of containing free electrons, but by reason of their great reluctance to form negative ions, *i.e.*, by reason of the exceptionally large proportion of electrons to ions. It would seem probable that in order to supply an appreciable number of negative ions, the molecules must contain atoms either of oxygen or chlorine, bromine or iodine. An explanation for this is advanced that an electron cannot effect a permanent union with an uncharged molecule to form a negative ion unless the relative velocity at collision exceed a critical value characteristic of the molecule concerned, which value is reduced by oxygen and halogen atoms.

The difference in mobility of the positive and negative ions in a gas is ascribed by the author to a difference in the attractive forces between each kind of ion and the uncharged molecules and their elastic properties. If the law of impact is different between the molecules of the gas and the positive and negative ions respectively, it follows that the rate of diffusion of the two sets of ions will in general be different. The general effects can be accounted for by two considerations: firstly, the discrete nature of the electronic charge, and secondly, the assumption that the positive and negative charges are differently distributed in the respective ions.

The Nature of Chemical Affinity. By W. M. Thornton, Armstrong College, Newcastle-upon-Tyne. *Philosophical Magazine*, Sixth Series, No. 199, page 66. In the absence of any knowledge of how an electron, acting as a bond, is anchored into the atomic structures of the combining atoms, the force that a bond sustains is assumed to obey the usual laws of attraction, and to be proportional to the masses of the molecules. In an explosive mixture before ignition, molecules collide without liberation of heat; but when activated in the explosion-wave front they combine with increased kinetic energy of which the heat set free is a measure. Formulæ are developed on the basis of these ideas, showing that, if true, the ratio $\frac{H^2}{m_1 m_2} = k$, where H is the total heat contained in the products of combustion, m_1 is the mass of the combustible molecule and m_2 is the mass of oxygen burned. The assumptions made above are substantiated in a study of the heats of combustion of a large number of compounds whose end products are steam and CO_2, from which $k = 38.6$, within limits. Hydrogen and CO are not reduced to the same products and their affinities are not comparable in terms of heat of combustion. For this reason it is impossible to compare the affinities of elements thermally, and heats of oxidation of metals differ widely. It is clear that affinity is not a simple electrostatic attraction, and that between elements it is dependent upon atomic formation.

Nitric Acid

Explosibility of Acetone-Air Mixtures.—On investigating the industrial conditions under which the vapors of inflammable liquids form explosive mixtures with air, Drs. R. V. Wheeler and A. Whitaker deal, in the account of their first research presented to the Chemical Society, with acetone, according to the *Chemical Trade Journal and Chemical Engineer* for July 14, 1917. This material is largely used in cordite manufacture, and rapid air currents may pass through long mains charged with acetone vapors. Laboratory methods have so far been used, because acetone vapor being soluble in water, glycerol, brine, etc., the vapor-air mixture must be stored over mercury, and the apparatus must be kept thoroughly dry. Experiments on the higher and lower limits of inflammability of the mixtures were made in tubes 2.5 cm., 5 cm., 10 cm. in diameter and 60 cm., 150 cm. and 75 cm. in length, for horizontal, downward and upward propagation of flame. When the diameter exceeds 5 cm. the pipe size influences the inflammability limits little, and it is concluded that the lower and higher limit would, for horizontal propagation in large pipes of about 60 cm. diameter, be 2 per cent and 10 per cent of acetone vapor. The speed of flame propagation was determined for the "uniform movement" of the flame, though it is known that this uniform movement is only observed in tubes of small diameters. In the 2.5-cm. tube this speed attained a maximum of 96 cm. per second in mixtures containing 5.5 per cent of acetone. For pipes of 30 cm., 60 cm. and 96 cm. diameters these speeds would probably be 2.5, 3 and 3.5 times as great. The quantity of acetone required for complete combustion of the oxygen in air would be 4.76 per cent.

Recent Metallurgical and Chemical Patents

Hydrometallurgy of Copper

Production of Trioxychloride—A patent for refinements of an earlier method has recently been issued to Charles S. Bradley, of New York City, in which crushed ore is heated with access of air to a temperature of 450 deg. to 550 deg. C., and thus subjected to an amphidizing treatment already patented (No. 1,011,562). The reactions vary with the ore and treatment, but the copper reverts to sulfate, containing some unaffected sulfide, some oxide and metallic copper, while the iron is mostly converted into ferric oxide, with some ferric sulfate. This roasted ore is then digested with a hot solution of calcium chloride, when the copper enters as soluble chloride, precipitating equivalent quantities of lime, thus:

$$CuSO_4 + CaCl_2 = CuCl_2 + CaSO_4$$

The cupric and other chlorides maintained in the solutions operate as secondary solvents for a number of the remnants which are insoluble directly in the calcium chloride solution. Sulfuric acid, mainly from the SO_2 in the dust and fumes, produces hydrochloric acid with the calcium chloride and any copper oxide present in the amphidized mass is converted by the hydrochloric acid into copper chloride. Metallic copper and copper sulfide react with cupric chloride forming cuprous chloride, the

sulfur of the sulfide being thereby set free and precipitated:

$$Cu + CuCl_2 = Cu_2Cl_2$$
$$CuS + CuCl_2 = Cu_2Cl_2 + S$$
$$H_2SO_4 + CaCl_2 = CaSO_4 + 2HCl$$
$$CuO + 2HCl = CuCl_2 + H_2O$$

Oxygen is supplied to the system at various points, so that this cuprous chloride is converted into oxychloride of copper which reacts with further quantities of hydrochloric acid, produced as described above, to form further quantities of cupric chloride. It should also be noted that the copper chloride is further maintained in the cupric state by the action of the iron chloride formed from ferric remnants in the solution apparatus.

$$Cu_2Cl_2 + O = Cu_2Cl_2O$$
$$Cu_2Cl_2O + 2HCl = 2CuCl_2 + H_2O$$

The mass is now filtered, and the solution carrying the values is subjected to further oxidation in order to insure that the values will all be combined at their highest valence and to prevent the formation of insoluble cuprous salts during subsequent treatments. A portion of the solute is now treated with sufficient cupric oxide, $Ca(OH)_2$ or $CaCO_3$ to precipitate all the iron and aluminium contained, and then the copper content thrown down as trioxychloride by $CaCO_3$, with the regeneration of the reagent, calcium chloride.

$$4CuCl_2 + 3CaCO_3 \quad CuCl_2 3CuO + 3CaCl_2 + 2CO_2$$

That part of the solution which was not so precipitated is used as a medium for absorbing the dust and fumes from the roaster, as described in the former patent. The presence of iron and aluminium salts, especially the iron, in the solution is desired as they are useful in this absorption, and also play an important part in taking values into solution. Furthermore it is desirable to retain a portion of the cupric chloride in the solution for reasons already apparent. These absorbing solutions are again oxidized and reintroduced into the normal cycle.

It will be seen that the carrier solution loses a small amount of chlorine in the above process, which can be conserved by a conversion of all the copper into cupric oxide, as follows: The trioxychloride after it has been filtered out from the carrier solutions may be treated by a number of chemical substances which will react so as to produce a soluble chlorine compound; for example, sodium hydroxide, sodium carbonate or bicarbonate of soda. Preferably, however, the trioxychloride is treated with a suitable calcium compound so as to restore chlorine to the system as calcium chloride. The treatment may be conducted at more elevated temperatures when a dry method is preferred or if a wet method is deemed more suitable the reaction in such cases would take place in the neighborhood of 100 deg. C.

The trioxychloride is brought into association with calcium oxide in water at about boiling temperature, whereupon the calcium unites with the chlorine forming calcium chloride and the copper unites with the oxygen forming cupric oxide. The cupric oxide being insoluble immediately precipitates out while the calcium chloride goes into solution in the water. It should be noted that the reaction referred to takes place more readily in dilute solutions. After removing the cupric oxide the calcium chloride solution may if desired be evaporated, which operation can be carried on in metal vessels as the solutions are alkaline and hence not active to the common metals. The main reaction is

$$CuCl_2 3CuO + CaO = 4CuO + CaCl_2.$$

The cupric oxide is removed from the solution by filtration. The calcium chloride solution may be introduced into the reaction or dissolving drum in the first portion of the process for repeating the cycle of operations. (1,236,046, Aug. 7, 1917.)

Electro-Osmosis

Tanning by Electricity.—A process for tanning and impregnating materials according to the principles of electro-osmosis is patented by Botho Schwerin, of Frankfort-on-the-Main, Germany (assigned to Elektro-Osmose Aktiengesellschaft of Berlin, Germany). As applied to tanning hide with tannin, the process is as follows: (The hide is assumed to have been plumbed with lime.) In Fig. 1 *A* is a rectangular ves-

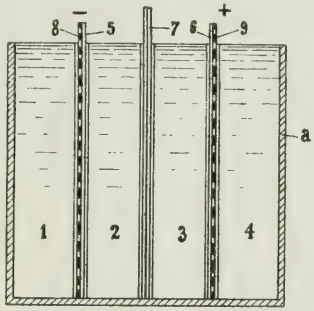

FIG. 1—SECTION OF TANNING APPARATUS

sel, subdivided into 4 compartments, by the diaphragms 5 and 6. The middle compartment is further subdivided into compartments 2 and 3 by the hide 7 which is stretched in a frame either directly or with use of a support. Behind the diaphragms are arranged perforated poles 8 and 9, in contact with the diaphragms. The latter may consist of a cellulose preparation, like parchment paper or viscose. The cathode chamber 1 and the anode chamber 4, are filled with water, which, in order to avoid resistance, preferably contains traces of caustic soda in the cathode chamber and of sulfuric acid in the anode chamber. In the anodic middle chamber there is water, in the cathodic middle chamber a dilute acid suitable for de-liming hide. When the electrodes are connected with the poles of a source of electric current, the hide is first purified in that the lime and other basic residues migrate out of it and pass into the cathode chamber through the feebly negative diaphragm. By this treatment the hide is caused to fall, and at the same time to become gradually of stronger electro-positive character. The first stage of the treatment is at an end when the de-adsorption of the basic residues is complete.

The tanning liquor is now charged into the chamber in front of the cathode. By the action of the electric current those cathodic constituents which could hinder the osmosis migrate through the cathodic diaphragm. On the other hand, the negative ions which prevent or limit the migration of the tannin migrate first through the hide and then into the anode chamber through the indifferent diaphragm. Proportionally to this progres-

sive purification of the tannin liquor, the solution of the tannin migrates through the hide and appears in the middle chamber 3, whence the solution is withdrawn. After it has been replenished it can be used again. This has the advantage that the longer the tanning liquor is used the purer it is. The anodic diaphragm must have such a potential that the actual ions can migrate through it, while the tannin cannot. If pure tannic acid solution, which contains no ions that can hinder osmosis, is used from the beginning, the hide need not be stretched in the middle chamber, but merely suspended therein. Circulation of the tanning liquor by stirring is then permissible.

If an impure tanning liquor contains acid residues, the osmosis of the tannin solution will not occur until the acid residues have passed the hide in order to be separated by the anodic diaphragm. If now by stirring the acid residues are again brought around to the cathode side, the migration of the tannin solution and therefore the tanning will be more or less delayed. So also basic residues which are brought by stirring to the anode side of the hide, act to diminish the electric charge of the hide by the back-migration, and this is obviously accompanied by a delay of the migration of the tannin. In impure tannin solutions, therefore, the hide must be stretched. (1,229,150, June 5, 1917.)

Electro-Osmotic Purification Process.—A process for removing suspended or colloidal matter from clay mixtures is patented by Graf Botho Schwerin, of Frankfort-on-the-Main, Germany (assigned to the Gesellschaft für Elektro-Osmose, of Frankfort-on-the-Main, Germany).

In an agitating tank the clay substance is suspended in water to form a thin mixture and to this is added a small proportion of a suitable electrolyte, such as sodium hydroxid. The suspension is run into one or more vats or basins and when there are several vats or basins the arrangement may be such that the liquid flows through them in series by means of conduits and the time during which the liquid is to remain in each may be selected as desired. From one or several vats the suspension is now conducted through pipes controlled by valves to an osmose apparatus, that is to say, an apparatus wherein the suspension is subjected to the action of an electric current. The character of the final product is determined by the concentration of the suspension between the electrodes of the osmose apparatus, the speed of the current and the nature of the added electrolyte, as well as by the strength and tension of the electric current. (1,229,203, June 5, 1917.)

Fused Silica

Fused Silica Articles.—Israel Rosenblum of Swampscott, Mass., has patented a method of producing articles of fused quartz in an atmosphere of nitrogen in graphite crucibles. The method is based upon the discovery that if a transparent quartz tube is slipped over a graphite rod and heated to a temperature between 1400 degrees centigrade to 1600 degrees centigrade in a nitrogen atmosphere, a compound of silicon, nitrogen and carbon is formed which acts as a protective coating over the graphite rod and prevents further action on the graphite by the quartz. As the melting point of the compound of silicon, nitrogen and carbon when once formed is far above the temperature needed to render the quartz plastic, which is about 1800 degrees centigrade, it follows that this compound acts as a protective layer, not permitting the quartz to be contaminated by the graphite. In practice illuminating gas may also be used. (1,229,324, June 12, 1917.)

Alloys

Iron-Chromium for Thermocouples, etc.—Alloys of iron, chromium and a small percentage of manganese for various purposes are patented by Albert L. Marsh of Detroit, Mich. (assigned to the Hoskins Manufacturing Company of Detroit, Mich.). The alloy is stated to be particularly useful for thermocouples or protecting tubes to be used in measuring the temperature of molten metal, particularly brass, at relatively high temperatures. The composition is approximately 25 per cent chromium, 2 per cent manganese and the balance iron. (1,229,770, June 12, 1917.)

Peat as a Reducing Agent in Smelting.—Nils Testrup of London, England, and Thomas Rigby of Dumfries, Scotland, have patented a method of utilizing peat as a reducing agent in smelting. The disadvantages of using peat are claimed to be overcome by using the Ekenberg process,

"known as wet carbonization, which consists in heating the peat under pressure sufficient to prevent ebullition to a temperature of about 180 deg. C., until its water binding properties are destroyed. Having thus been treated, the peat can readily be de-watered by filter-pressing, which produces press cakes suitable for use as the reducing agent, when directly added to the furnace charge, or after having been further dried and converted into briquets, which are then added to the charge.

"In this way, preliminary coking hitherto usual is rendered unnecessary, as it takes place in the furnace itself, while the hardness and crushing strength of the coke thus produced from the filter press cakes is equal to that of the best wood charcoal, and that from the briquets equal to the crushing strength of the best smelting coke, with the result that such coke is able to carry the weight of the charge.

"In carrying the invention into effect, as applied to smelting iron ore in a shaft furnace of the type described in Patent No. 1,106,166, the peat is heated to a temperature of about 180 deg. C., in a carbonizer of the well-known concentric tubular type, under pressure sufficient to prevent ebullition, until the water binding properties of the peat have been destroyed, whereupon the material is subjected to filter pressing, which results in the production of filter press cakes having a water content of about 70 per cent. To the furnace charge, consisting of iron ore and limestone, the filter press cakes are added, either as such, or as briquets formed after drying the material until its water content is about 5 per cent. In gradually descending therethrough the peat becomes coked by the hot uprising gases from the hot zone, while the products of destructive distillation pass off with the shaft gases at the top of the shaft, and are treated for recovery of nitrogen and tar, preferably by introducing the gases into the foul main of an ammonia recovery gas producer if, as often occurs, such is used for power, and fuel gas generation in the plant and which latter may conveniently also be supplied with peat press cake, briquets, or a mixture thereof.

"An intimate mixture of the furnace and producer gases results in such an event and the combustible value of the latter is consequently enhanced.

"We have observed that the temperature of coking the material in question is less important as affecting the strength of the product than the pressure employed in forming the cake or briquet, and consequently low coking temperatures such as prevail in the shaft can be used, and a high nitrogen recovery obtained. (1,233,144, July 10, 1917.)

Reorganization of Washington State College.—Reorganization of the Washington State College, here, will give a prominent place to the School of Mines, making the school one of the eight schools or colleges of the institution. Prof. Francis A. Thomson, head of the mining department, will become Dean of School of Mines.

The Greaves-Etchells Electric Furnace

By E. Kilburn Scott, A.M. Inst. C.E., M.I.E.E.

Since the war, one of the most striking developments of the steel industry of Great Britain has been the rapid increase in the number of electric steel furnaces. So successful have they been that the prejudice against this type of furnace is rapidly disappearing, and the change will probably rank as the most radical one in steel metallurgy since the time of Bessemer.

Among factors which have helped to bring the electric furnace into favor are the following:

(a) The war-demand for special tool steel for tools, dies, gages, etc.

(b) The demand for chrome and other special alloy-steels for aircraft tubing, and other high strength parts.

(c) The difficulty of obtaining Swedish iron, which besides being scarce, is extremely expensive.

(d) The difficulty of obtaining skilled labor to work the crucible steel process.

(e) The necessity of using turnings, millings, ends of tubes, bars, and other scrap steel.

(f) The ease with which high-class steel can be made from second grade materials.

For these reasons, furnaces of many well known types are now in operation in Great Britain, including the Heroult, Girod, Snyder, and Gronwall. Another furnace, which has met with considerable success, is that of Greaves-Etchells. As this is an all-British production both in inception and manufacture, a detailed description will be of interest. It is designed to operate on a three-phase or a two-phase supply, and in the former case has two of the phases connected to electrodes above the bath, the third phase being connected to a copper plate below the conducting hearth of magnesite. This furnace was first noted in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XV, page 680, December 15, 1916.

The furnace body consists of a rectangular tank made of boiler plate, strengthened by angle sections. The bottom is dished and has two steel rails rivetted to it. These rest on grooved steel rollers, and the whole furnace with its electrodes can be tilted backwards and forwards by means of a screw and gear wheels.

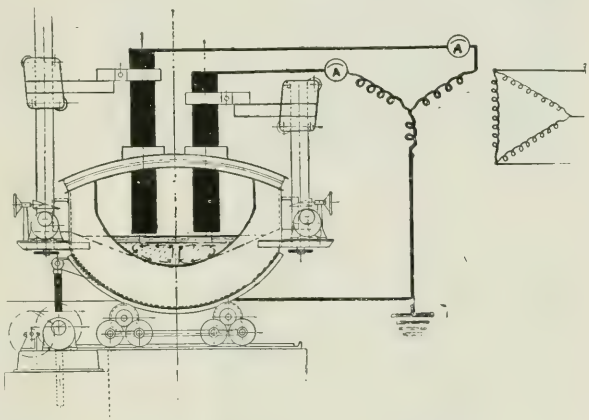

FIG. 2—SECTION OF 6-TON FURNACE

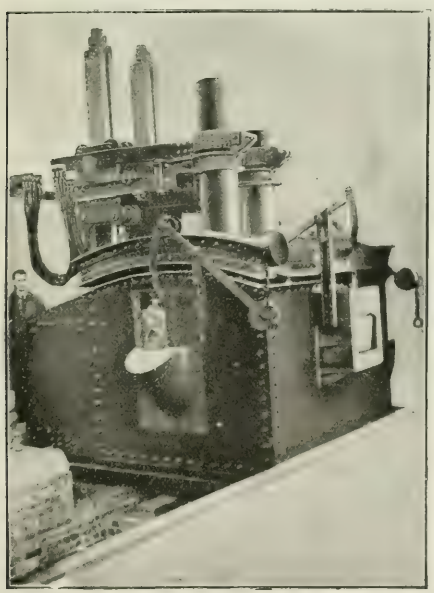

FIG. 1—VIEW OF 3-TON FURNACE

Each electrode is secured in a holder made of bronze or steel and each holder is attached to, but insulated from, a steel jib, projecting from a wheeled carriage. The carriage travels up and down a vertical mast which is made of two channel sections bolted to the side of the body. In small furnaces the electrodes are regulated by a hand wheel and in large furnaces by a motor driving through single reduction gearing.

The roof is made of silica bricks, as these are fairly good electrical insulators. They are set in a steel frame which rests on the silica brick walls, projecting above the steel body of the furnace. The roof is domed and brought as low as possible so as to reduce the wasting away of the electrode by action of the hot furnace gases. A roof will last about 100 heats and a duplicate one is provided with each furnace, so that the steel melting can be carried on except for the short time taken to change the roof.

In order to obtain an even temperature through the bath of molten metal in the electric furnace it was realized that heat must be applied below as well as above the bath, and in order to effect this the hearth of the furnace is specially constructed. About 12 per cent of the total energy of the Greaves-Etchells furnace is used in the hearth, and the "bottom heating" which results is found to be of great advantage in melting down alloys. The heavier alloys, chrome, tungsten, vanadium and nickel, sink to the bottom of the bath and if there is no bottom heating are apt to remain for a considerable time in a semi-fluid state.

The hearth lining is never less than 20 in. thick and

is constructed mainly of dolomite and magnesite in such a manner that the electrical resistance is high at the inside of the bath in proximity to the charge, and decreases rapidly to a small quantity at the outside. The current flowing through the hearth generates a considerable amount of heat immediately below the liquid in the most efficient manner possible, while the electric arcs arranged over the bath maintain the slag and surface at the desired temperature. The effect of this bottom heating is to cause convection currents in the molten metal, which insure a constant circulation, and a uniform product. The outside of the furnace bottom remains cold, comparatively little heat being lost in this direction.

At first sight the connections would appear to cause an unbalanced load on the primary supply, but the transformer ratios are arranged to give a perfect balance when the upper electrodes are in equal adjustment. The high tension electric supply is transformed by means of a delta-star system of connections to low tension, the transformer house being as near as possible to the furnace in order to avoid heavy copper costs and energy losses in the low tension connections.

The equipment has to be designed to withstand short-circuiting of the electrodes, as this occurs in all furnaces during the melting process when pieces of metal fall against the electrodes. The method usually adopted by furnace builders to provide against this is the introduction of consideration reactance in the electrical system, but unfortunately this reduces considerably the energy available in the furnace, it increases the energy losses, and also is a very objectionable load for a transmission system. The Greaves-Etchells system of transformer connections is such that the short-circuit current of one electrode must traverse two transformers in series and in different phase, which automatically lowers the power factor momentarily, and has a very strong buffer effect; the fact that there is always a permanent resistance in the path of the current through the hearth also limits very considerably the effects of short circuits. The combination of these factors provides the most effective means yet devised for protecting the supply system from surges, while allowing a high power factor to be obtained on normal load.

In all electric steel furnaces the metal is poured by tilting the furnace, and when this is effected by mounting the furnace on rockers, the end of the spout not only moves downwards but also away from the ladle. Clearly the only way to keep the spout in one position would be to rotate the furnace round it, but this is out of the question because it would mean lifting the furnace bodily and take too much power. A furnace of 10-tons capacity for example may weigh as much as 90 tons. The makers of the Greaves-Etchells furnace have compromised by arranging for the spout to descend in a vertical line so that the furnaceman and crane-man have merely to see that the ladle is lowered while the metal is running out. This is effected by the system of compensating rollers shown in Fig. 2. The furnace is carried on two sets of rollers, and as it is tilted it causes the top rollers to rotate the bottom rollers and thus move the furnace bodily forward. The wheels are so proportioned that the forward movement will keep the end of the spout moving in an approximately vertical line.

Greaves-Etchells furnaces are made in the following sizes:

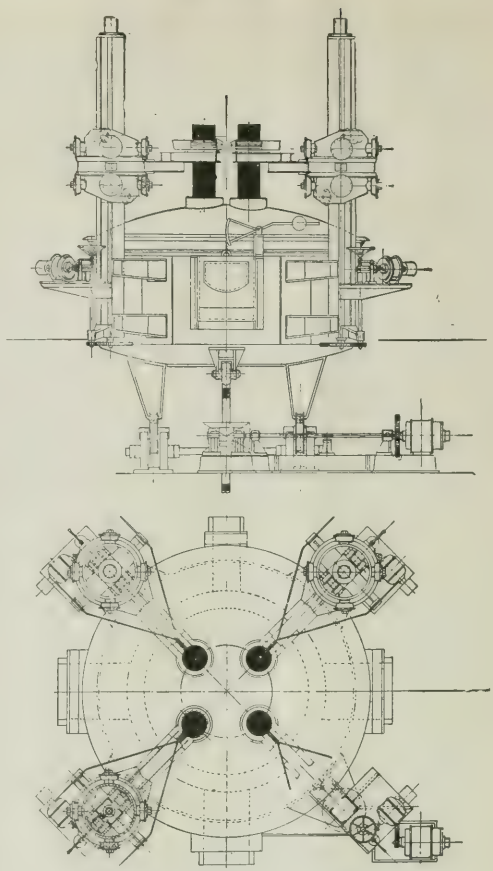

FIG. 3—PLAN AND ELEVATION OF 10-TON FURNACE

Charge	K.V.A.	Electrodes	Diameter of Graphite Electrodes
½ ton	260	2	4 in.
1½ tons	520	2	7 in.
3 tons	800	2	8 in.
6 tons	1,300	4	8 in.
9 tons	2,000	4	9 in.
12 tons	2,600	4	10 in.

For the manufacture of high speed steels or special alloy steels a ½-ton or 1½-ton furnace is usually adopted, and the furnace can finish a charge from cold material and alloys in 2 to 2½ hours, with an energy consumption of 400 units.

To make up a charge from scrap, it is usual to place steel turnings and millings on the hearth, then pieces of bar, rail and tube ends, and finally large pieces of steel. The interstices between the large pieces are filled with turnings, and some iron ore may be added. The amount of iron ore needed depends on the amount of iron oxide already present in the form of rust on the scrap. As the charge is melted, a slag of lime and fluorspar is made in order to eliminate the phosphorus. After this phosphate slag has been skimmed off, a new slag is made up of best lime, fluorspar and white sand in the proportions of 30, 10 and 5. When this has fluxed, a small quantity of finely powdered anthracite coal is spread on the slag. This charging of anthracite is

continued until the slag is deoxidized. The steel is thus finished under an atmosphere of carbonic oxide, and a slag from which the metallic oxides have been reduced. When entirely deoxidized, a sample of slag falls to a fine white powder as it cools. Deoxidation of the slag results in deoxidization of the steel, through the constant reduction of silicon from the slag, and it may be hastened by addition of small quantities of ferro-silicon.

Owing to low heat efficiency and high cost of labor crucible steel is much more expensive to manufacture than electric steel. Already several steel works have shut down their crucible plant after installing electric furnaces. The introduction of the Bessemer and open-hearth processes of making steel left crucible steel makers indifferent, owing to the fact that those methods were employed for making ordinary kinds of steel in great quantity for structures, rails, etc. The coming of the electric furnace is a different proposition, as it competes directly and successfully in the special field that the crucible steel process has held so long. In conclusion it may be mentioned that very soon there will be over fifty electric furnaces at work in the Sheffield district and the output of steel from them will be at the rate of over 200,000 tons per annum.

London, England.

Flash Annealing Large Projectiles

By Edward A. Pilnacek

In the manufacture of large projectiles, the rough shell is brought to a temperature of 1650 deg. Fahr. and then water quenched. This leaves the metal, especially the outer skin, glass hard. To allow machining, this outer skin must be softened without affecting the hardness of the inner metal. In order to obtain this effect, the shell surface must be heated to about 900 deg. Fahr. with sufficient rapidity to preclude the possibility of the inner sections of the metal having time to absorb enough heat to materially affect their hardness. This softening of a thin skin of metal is called flash-annealing.

The accomplishment of the effect explained above has been a rather difficult task. In one of our large steel mills quite a variety of types of oil and electric furnaces were tried out, the results, however, proving unsatisfactory. The shells would come through with hard spots and could only be machined with great difficulty. Two Surface Combustion gas-fired flash-annealers were finally installed and satisfactory results obtained.

The above mentioned furnaces are run on a low pressure system, air being delivered from a positive pressure blower. The quality and quantity of the mixture are controlled by a one-valve, low-pressure control. The heavy firebrick walls of the furnace,

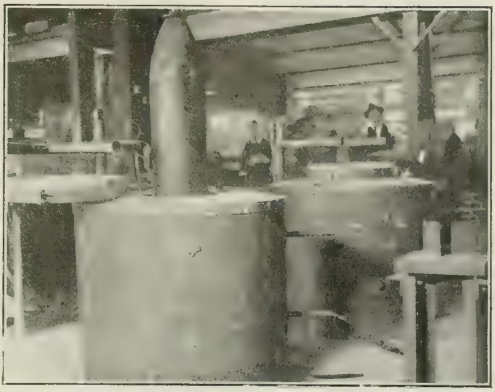

FIG. 1—FLASH ANNEALING FURNACES IN OPERATION

backed up by ample insulation, are encased in a heavy sheet metal casing, mounted on a cast iron base. The base rests on a foundation set in a shallow pit of a depth to bring the top to a convenient working height. The covers are of the usual swing type.

Fig. 1 shows the two units in operation.

Later, due to the manufacture of a larger shell, it was necessary to procure two additional flash-annealers.

Fig. 2 illustrates the latter type of furnace.

The burners are placed radially, and their nozzles are made,

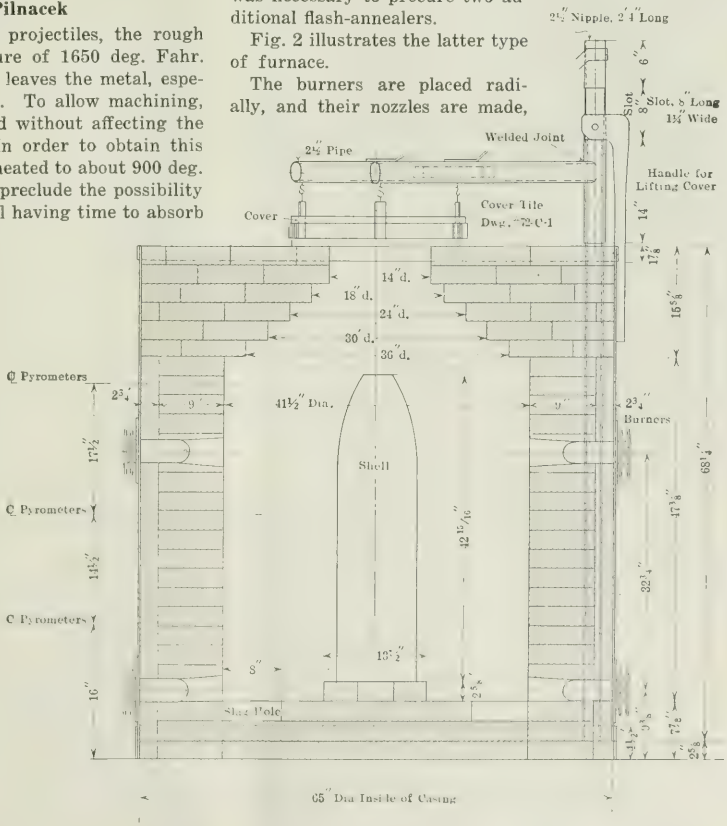

FIG. 2—FURNACE FOR ANNEALING 330-LB. SHELLS

so as to shoot the mixture tangentially upon the inner furnace walls. This causes a revolving sheet of mixture, thus giving rise to a scrubbing action of the hot gases, insuring as nearly a uniform temperature as possible at all points on the surface of the furnace. When the furnace is cold, the tunnels at the end of the burners allow complete combustion of the mixture to take place by retarding its velocity before the cold furnace walls are reached. These furnaces are of a later design using heavy firebrick walls and insulation as in the former furnaces, but run on a high pressure gas system.

The quality and quantity of the mixture are controlled by a single pipe, one-valve, high-pressure control. Gas at 2 in. of water pressure is raised to 10 lb. gage pressure by means of a booster. This high pressure gas draws in the necessary amount of atmospheric air by means of an inspirator, thus eliminating any air pipes and making a very compact furnace.

In this second installation it was deemed advisable to set the furnaces at floor level and build a platform around to enable the men to operate from a convenient working level.

The operation follows: It takes one and a half hours to bring furnace from room temperature and soak it at 1650 deg. Fahr., using 720 cu. ft. of 600 B.t.u. gas per hour. This time can be cut down if desired. When furnace has come to temperature the door is swung open and a shell lowered into it by means of an overhead crane. The shells remain in furnace anywhere from seven to fourteen minutes, the average taking ten minutes. During this time a gas rate of 540 cu. ft. per hour is maintained and at the end, the furnace temperature drops to about 1420 deg. Fahr., while the shell surface is brought to about 900 deg. Fahr. After shell has been removed and the door closed the gas rate is raised to 720 cu. ft. per hour, bringing the furnace back to 1620 deg. Fahr. in five minutes.

In this manner two furnace units turn out seven shells, weighing 330 lb. each, per hour. A few minutes are lost in handling the shells during which time furnace temperature is held with 480 cu. ft. per hour with the door open. The gas consumed per hour by the two units sums up to 1170 cu. ft., giving 168 cu. ft. gas used per shell.

Engineering Dept.
The Surface Combustion Co.,
Long Island City, New York.

Book Reviews

A Laboratory Manual of General Chemistry, with Exercises in the Preparation of Inorganic Substances. By **Arthur B. Lamb.** VI and 166 pp. Interleaved with 130 pages for notes. Cambridge, Harvard University Press, 1916.

Reviewed by Henry Max Goettsch,
Asso. Prof. of Chemistry, Univ. of Cincinnati.

In justification of adding another laboratory manual to the already existing long list of similar works, Professor Lamb has written an interesting preface, from which the following may be quoted:

"This laboratory manual has been written to meet the requirements of students of chemistry *who already possess an elementary knowledge of the subject.* (Italics are mine.) . . . How best to continue the chemical education of such students is one of the most difficult problems which confronts teachers of chemistry in our colleges and universities. . . . A time honored practice has been to ignore secondary school preparation entirely and give identical instruction to these men and to real beginners indiscriminately. *This was doubtless justifiable some years ago . . . but to-day it can only be defended on the ground of necessity.* The larger institutions recognize this and either have arranged separate laboratory sections for the differently prepared students, or, better still, give them wholly separate instruction. . . .

"The requirements then to be met by a laboratory manual of this kind are by no means easy. The most essential are, first, that those important facts and principles which the student has already studied shall be reviewed in a way sufficiently novel not to bore him, nor to encourage him to overconfidence; second, that the student's chemical horizon shall be widened by the study of new and unfamiliar substances; and third, that further important generalizations upon which the superstructure of the science is based, shall be disclosed and made clear."

With these requirements the reviewer is in substantial agreement. Turning to the contents of the manual we find them arranged in the form of fifty numbered experiments in general chemistry, constituting Part I, and of seventeen exercises in the preparation of inorganic substances, constituting Part II.

To all teachers who are fortunate in having to deal with students "who already possess an elementary knowledge of the subject," and in the opinion of the reviewer a *good* elementary knowledge should be a prerequisite, this book will make a strong appeal. It possesses many points of decided merit. There are a number of well-chosen quantitative experiments, *e.g.*, the composition of cuprous oxide, cuprous sulphide, and sulphur dioxide. An unusually large number of interesting experiments emphasize the modern aspects of the subject as brought about by the development of physical chemistry, as *e.g.*, the velocity of chemical reaction, chemical and ionic equilibrium, colloidal solution, etc. In this respect the book is to be classified as ultra modern. Three experiments are devoted to organic chemistry. This small number would seem of doubtful utility, and might profitably be eliminated in brief courses in order to gain more time for other topics.

A sufficient amount of the usual fundamental subject matter found in works of this character is given. It is of course impossible for any book to meet completely all the individual wishes of different teachers. Thus under sulphuric acid, Exp. XXI, there is given the charring action on paper, its oxidizing action on hydrogen sulphide and charcoal, and its precipitation reactions with barium, lead, and calcium salts. This would seem a rather brief treatment of this important substance and one might imagine that these points ought to have been covered in any good elementary course, and might have been eliminated in favor of experiments illustrating the chamber and contact processes.

The author states that he has purposely avoided the insertion of tests of significance only in systematic analysis. Many will not agree with him here; general chemistry offers splendid opportunities not only for an introduction to physical chemistry, but also to analysis. In this connection the complete elimination of the blow-

pipe is to be regretted; all of the older masters were adepts in its use, and its practice constitutes a pleasure for most students on account of the ease, rapidity, accuracy, and elegance of the results achieved by its use.

But these are minor points. Pedagogically the book shows everywhere the hand of the experienced, careful teacher. The "General Instructions for Laboratory Work" should prove of great value in any course. In every exercise we find assigned readings, page references being given to the excellent text of Alexander Smith, then a "Discussion" in which fundamental principles are clearly set forth, to be verified in the succeeding experiment. Full directions are given which should permit accurate work on the part of the student. Interesting "Outside Questions" conclude each exercise. These are to be solved by outside reading or reflection.

The author is fortunate in possessing a clear and direct exposition enabling him to put difficult topics in a simple and comprehensive fashion. He has given us an excellent book. The chief criticism to be levied against it, in the opinion of the reviewer, is that it is ahead of its time. Many institutions at the present time unfortunately will not have students adequately prepared to undertake its study.

The Iron Ores of Lake Superior. By **Benedict Crowell** and **C. B. Murray.** Third edition. The Penton Press Company, Cleveland, Ohio.

This book is compiled from various sources, and contains much statistical matter of interest to the miners and users of Lake Superior ore. The bulk of the book is occupied by notes on the individual mines of all the Lake Ranges. The following data is given for each mine: location, date of opening, character of ore, mining methods, depth, method of shipment, name of operator, manager and sales agent, yearly tonnage shipped since opening, and average cargo analyses of dried ore and the ore in its natural state. Good maps of each range show in color the location and extent of the ore deposits.

Introducing this portion of the book are elementary chapters on the history, geology, mineralogy, and mining methods. Then follows detailed information as to present and past freight rates, total ore shipments, dock equipment, and ore-loading records. Standard methods for sampling, analyzing and valuation of the ore are given, and an interesting chapter on beneficiation of ores also appears.

The book contains an enormous amount of information concerning the operations of this most important region, and it would be most useful to those having business relations with producing companies.

Commercial Sampling and Analysis of Coal, Coke and By-products. Methods in use by the United States Steel Corporation. The Chemists' Committee, **J. M. Camp,** Chairman.

The personnel of the sub-committee which prepared this most excellent pamphlet is sufficient guarantee of its qualities, consisting of such men as J. R. Campbell, of the H. C. Frick Coke Company; I. A. Nicholas and C. N. Norris of the Carnegie Steel Company; J. R. Harris of the Tennessee Coal, Iron & Railway Company; William Brady, J. V. Freeman and H. H. Jones of the Illinois Steel Co. It will be of extreme interest to all technical men interested in the analysis and purchase of coal and its products, and should eventually be as well known in the laboratory as is the American Bridge Company Standards in the drawing room.

As indicated in the preface, the committee has acted as a free lance in the by-product field, selecting those methods that seemed to give the most consistent results and harmonize best with plant practice, regardless of where they were to be found. No claim is made for permanency, as this field is marching so rapidly that it is impossible to formulate lasting methods save in the fundamentals.

A special feature is the progressive dry distillation method for determining the relative yields of coke and by-products from bituminous coal which should commend itself to various by-product plants, laboratories, and engineers. Although the results obtained are somewhat relative, frequent comparison of laboratory results with those obtained in actual practice will establish the proper correlation.

The Journal of the Institute of Metals. Vol. XVII ("Metal Melting" Number). Edited by **G. Shaw Scott,** M. Sc. (The Institute of Metals, 36 Victoria Street, London, S. W. 1., 21/s. net.)

Though the latest issue of "The Journal of the Institute of Metals" would be noteworthy if only on account of its containing five communications of exceptional importance bearing on as many different phases of metallurgical work, what distinguishes it from any previous volume published by the Institute, or elsewhere, is the fact that it brings to a focus the very latest ideas, information and criticism with regard to the subject of the melting of the non-ferrous metals—obviously a question of extreme moment in these days of munition-making and fuel economy. In spite of the war, which renders the continued regular publication of such scientific literature as this a matter of some difficulty, the "Journal's" amount and quality of contents are quite up to pre-war standards.

Personal

Dr. **Victor C. Alderson,** consulting engineer of Boston, has been tendered the presidency of the Colorado School of Mines at Golden, Colo. Dr. Alderson served as president of the school for ten years, retiring three years ago to devote his entire time to professional engagements.

Mr. **L. W. Bahney** has left the Sheffield Scientific School, Yale University, to accept a position as metallurgical engineer with the Scovill Manufacturing Company, Waterbury, Conn.

Mr. **De Courcy Browne,** metallurgical engineer, Goldschmidt Thermit Company, 120 Broadway, has been commissioned a second lieutenant in the ordnance department of the U. S. Army, and is connected with the second training company, Coast Artillery Corps, Fortress Monroe, Va.

Dr. **Hardee Chambliss,** chemical director of the Commercial Acid Company of St. Louis, has been commissioned major in the ordnance section of the Officers' Reserve Corps.

Mr. **Bancroft Gore** of Butte, Mont., has taken the position of metallurgical engineer of the Societe des Mines de Cuivre de Naltagua, at El Monte, Province of Santiago, Chile.

Mr. **J. H. Jowett,** formerly general sales manager, was elected vice-president of the Ingersoll-Rand Company, and Mr. L. D. Albin, formerly assistant general sales manager, was appointed general sales manager, at a meeting of the Board of Directors of the company.

Mr. Jowett and Mr. Albin will continue to make the company's New York office, at 11 Broadway, their headquarters.

Mr. **Dyke V. Keedy** has been in the three Guianas in South America since last January. He expects to arrive in New York City about Sept. 1. He reports having had a most interesting trip.

Prof. **Lionel S. Marks,** professor of mechanical engineering at Harvard and Massachusetts Institute of Technology, has been assigned by the national advisory committee on aeronautics to take charge of investigations relating to airplane-engine design now being made at the Bureau of Standards.

Mr. **C. E. McQuigg** has been given leave of absence from the position of associate professor of metallurgy at the Pennsylvania State College and is stationed at the Winchester Repeating Arms Company, New Haven, Conn., as Captain in the Ordnance Department of Officers' Reserve Corps in charge of material inspection and heat treatment.

Mr. **H. A. Richmond** has been elected managing director and treasurer of the General Abrasive Company of Niagara Falls, N. Y., and has relinquished his connection with the American Emery Wheel Works, of Providence, of which he has been president and technical expert for the past twenty years.

Mr. **F. L. Webster,** formerly manager of the San Francisco district office of the Allis-Chalmers Co., has been appointed manager of the Chicago district office, succeeding Mr. **F. von Schlegell,** resigned.

Obituary

Oscar Edmund Cary, prominent in the mining and metallurgical world has passed away. Mr. Cary, while not a mining or a metallurgical engineer by profession was connected with mining and metallurgy for many years in a business way.

Mr. Cary was born on Aug. 11, 1864, at Fort Wayne, Ind. After completing a high school course his first business activities took him to Chicago where he was connected with the Fuller & Fuller Drug Company. From here he went to Omaha, Neb., as representative for the T. W. Harvey Lumber Company. In 1893 he came West and started one of the large fruit ranches of the time near Provo, Utah. After eight years he entered the services of the American Smelting & Refining Company with which firm he remained until 1905. From then on he was connected with the Ohio & Colorado Smelting & Refining Company at Denver, Colo. This was to be his last field of action. He was assistant general manager and much beloved by the members of the firm. His death came on Monday evening, Aug. 20, 1917, at his home, 1515 East Eighth Avenue, Denver, Colo., and was due to heart failure.

Mr. Cary is survived by his mother, Mrs. Rebecca Cary, his brother W. H. Cary, who is also connected with the Ohio & Colorado Smelting & Refining Company; by a second brother H. E. Cary at Chicago and by an only son Webster Cary, superintendent of the Consolidated Copper Mines Company, of Kimberly, Nev. He was very prominent in Denver circles, having been a member of the Rotary Club, the Country Club and the Civic Association. His death is lamented by all his friends and in fact by all ever having had any connections with him.

Adolf Ritter von Baeyer, professor of chemistry at the University of München and one of Germany's best-known organic chemists, passed away during the latter part of August in Germany. He was best known for his work in coal tar chemistry, especially synthetic indigo and eosin. He was a professor at the University of Berlin in 1866, at Strässberg in 1872, going to München in 1875, where he built a large new laboratory. He did considerable work in the laboratory of Graebe and Liebermann in 1868. In 1905 he was the recipient of the Nobel prize.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Saturday, Aug. 25.—The metal markets remain intrenched in their stagnant position. Prices are practically unchanged on the important items, such as copper, lead, tin and spelter.

Copper.—The copper trade has been awaiting the price agreement between the producers and the Government. What few sales have been made have been consummated at prices averaging 29.00 cents for Lake and 27.00 cents for electrolytic, which are the prices quoted at the present time.

Tin.—Tin remains at 62⅛ to 62½ cents for Straits, with no new developments. Other grades of tin, such as Banca and Chinese, are offered at several cents under Straits as usual.

Lead.—The only thing of interest in the lead market is a slight disposition on the part of independents to shade their prices. They are asking 10½ to 10⅞ cents, with the Trust price remaining at 11.00 cents.

Spelter.—Dullness continues with prompt spelter nominally quoted a trifle lower at 8⅛ cents.

Other Metals	
Antimony, Chinese and Japanese, pound	$0.15
Aluminium, No. 1 Virgin, 98-99 per cent, pound	.48
Magnesium, metallic, pound	2.00–2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask	115.00
Silver, ounce	.88¼
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

The Iron and Steel Market

The iron and steel market continues in a stagnant condition. In other words, it continues to make progress towards a general readjustment on a lower scale of market values. The situation is the familiar one that always develops after a period of heavy buying with rapidly advancing prices. The final resolution sees quick action, but the preparatory period is just as essential, the mutual obligations of buyers and sellers being in process of fulfillment preparatory to the making of a fresh start.

The unique feature of the present readjustment is that the Government is involved and the extent of its connection is not known. The Government now exercises certain influences and may exercise more. It has power to fix prices on the steel it buys for prosecuting

the war, prices much lower, of course, than those quoted for some time past as representing the market, and these prices are largely unfixed as yet. When fixed they will exert an influence upon the minds of buyers, encouraging them to expect lower prices also. The Government exerts also a sentimental influence upon buyers, by the "one price for all" doctrine enunciated by President Wilson on July 12, a doctrine which the recently created War Industries Board, for purchasing supplies, has reiterated. The inference in the minds of many is that if iron and steel prices do not recede satisfactorily the Administration will seek power through legislative action to bring them down.

In another manner, both direct and sentimental, the Government can, or rather will, exercise an influence upon iron and steel prices, and that arises from the power given the President by the Food Control Law to fix prices for coal and coke. When on Aug. 21 the Administration announced coal prices at an average level of $2 per net ton at mine for mine-run it set a lower figure than had been expected, and the impression was naturally given that it would seek the establishment of lower iron and steel prices than had been expected. That influence helping the market towards its readjustment is sentimental, as in the aggregate the cost of producing steel is not greatly reduced. A direct influence will be exerted when a lower price for coke is forced, as the cost of making pig iron will be materially reduced, and buyers of pig iron will be further confirmed in their policy of staying out of the market until prices are lower.

Transactions in pig iron are practically nil, business being confined to very small lots for early shipment, with occasional resales of somewhat larger lots. Through such reselling Bessemer has scored a decline of $2 a ton, to not over $53, valley, the offerings being of iron that had been bought for export but could not be moved.

In unfinished steel there has been more action, but as to quotations rather than actual turnover of tonnage. The advance in billets was completed early in June, the established level then being $95 to $100. For a few weeks this represented an actual market, the quotation later becoming nominal, awaiting a reduction through actual offerings at lower prices. These began just before the middle of August, and before the end of the month there were offerings down to $75 which found only an occasional taker, so that, apparently, the $20 decline was only the beginning. Sheet bars, which had attained a level of $105 to $110, were offered down to $85 if not lower.

The decline in the scrap market, which began late in June, continued until the past fortnight, in which period there has been some tendency to reaction towards a slightly firmer condition.

In finished steel products the stagnation which began about July 1 has continued, and has, if possible, been accentuated in the past week or two. Domestic buyers have shown wonderful powers for staying out of the market, as even their purchases for early deliveries are relatively small. The case of export demand is different, there being heavy demand for various products, including plates and sheets in particular, and even higher prices than formerly are bid for sheets.

There has, however, been no definte decline in finished steel products, which are, with the possible exception of plates, quoted at as high prices as formerly. The export embargo on scrap, pig iron, billets, etc., plates and structural material, which became a tight one Aug. 15, when the Government ceased to grant permits except when it could be shown that the material to be exported would be used strictly for prosecuting the war, has had some influence upon the plate market, as deliveries of large tonnages have been held up, and the mills do not know whether to continue rolling upon their orders in expectation of permits being granted later, or to offer to sell their capacity over again in the open market. There have been occasional offerings of plates in consequence at lower prices, down to 8c.

Production increased somewhat the latter part of August on account of a moderation in the weather. Production of steel ingots in the first half of the year was at the rate of about 43,000,000 tons, against actual production of 41,400,000 tons in 1916, while July showed an average rate of 44,000,000 tons and August will make a still better showing. The gain in production over 1916 is decidedly less than the increase in capacity.

Mills are steadily reducing the volume of their obligations on books, but it will be several months, in most instances, before they stand in need of additional orders. While the average shipping value is constantly increasing through the working off of older and lower-priced orders, the average invoice price at this time is but little more than half the present quotable market, which is one that was developed on relatively prompt deliveries after the buying for regular forward deliveries had dropped to small proportions.

Chemical Market

Benzol.—The ultimate attitudes of the allied governments regarding the purchases of picric acid are still an unknown equation, and the movement in benzol has been slow. Domestic consumers are playing a waiting game and following the issues carefully; in the meantime supplies appear to be accumulating somewhat, and there is a noticeable effort on the part of some producers to dispose of their surplus holdings, with the attendant result that the market is not particularly strong.

Nitrobenzol.—A routine movement of stocks is going on, but demand is far from active. Prices, however, are remaining moderately steady. *Dinitrobenzol.*—Production of this intermediate is not large enough to allow of much surplus, although there is not an unusually heavy demand. Prices have not been given to marked revision, and sellers' ideas are unchanged. *Dinitro Chlorbenzol.*—With a somewhat greater production, stocks are more or less plentiful, and within the last few weeks competition has induced somewhat lower figures. *Monochlor Benzol.*—One or two moderately good export orders have recently been placed, and a fair domestic demand has been in evidence. The fact, however, that production has increased has kept the market at comparatively low levels, and there is no expectation of an immediate advance in values.

Toluol.—Because of the fact that a very large percentage of production is going directly into consumption on Government contracts, and for dye manufacturing enterprises, a comparatively small amount is reaching the open market. Prices are firm and the tendency is toward continued firmness. This attitude is reflected in the fact that some large producers are not taking a pound of outside contract business and others quote prices at least equal to the spot market. *Ortho-*

Toluidine.—Ortho production is still confined to comparatively few sources, a fact which keeps supplies limited, and barely able to cope with the steady demand that is in evidence. Prices show considerable firmness. This condition is even more true of the *Para*, of which a smaller yield is returned; demand is heavier, and some makers are not in a position to take business for immediate delivery. Prices have advanced and are now firmly maintained at $2.00 to $2.25. *Ortho Nitro Toluol* and *Para Nitro Toluol* have been in fairly urgent request and under light supply the market is holding with no little firmness.

Xylol.—While demand has broadened somewhat the increased production has been instrumental in bringing about a situation that not altogether makes for optimism on the part of producers. Supplies in some directions have accumulated and the pure grade is offered at times at lower prices. This is also partly true of the commercial.

Phenol.—The undertone is considerably stronger, and there appears to be a slight upward movement. Recent large purchases took much of the surplus from the market, and leading sellers who have not sold up for nearby delivery have advanced their prices from one to two cents.

Dinitro Phenol.—With domestic production somewhat in excess of immediate demand, there has come about a much easier tone to the market, reflected in present prices which are from 5c. to 8c. below the figures quoted two weeks ago.

Naphthaline Flakes.—Some moderately important business has been passing during the fortnight although as production goes along steadily, supply is at least equal to demand, and prices have been shaded somewhat for nearby delivery and contracts.

Heavy Chemicals.—The sharp upward movement in soda ash during last week was not particularly surprising, in view of the fact that producers for the most part had been in a well sold up condition for some time. Neither, however, was the reaction which set in the latter part of last week and which continues now, of a very surprising nature; for while the firmness is justified, the advance was brought about to a great extent to speculative holders who control a large share of available supplies. *Caustic Soda.*—The continued strength and steady advance of this material has been more or less phenomenal. Trading for nearby delivery, and on all forward positions is only restricted by the meagerness of offerings. While it is true that speculative interests have played a more or less important part, the consuming demands and export requirements have been the big factors in producing the tight situation that now prevails.

Bleaching Powder.—While this article has been dull all summer, and prices have been unusually low, there is now a somewhat firmer tone to the market, induced by the widening of inquiry both for domestic use and in export packages. The fact that makers are confident that the market will regain its lost strength is evidenced by the higher quotations made for future deliveries than for spot business.

Chlorate of Potash.—The market is moderately firm and there is a tendency noted in some directions toward higher prices. The absence of important demand, however, keeps the market from advancing. The Japanese product is offered here from some quarters at moderately lower figures, and some business is reported. *Chlorate of Soda* is coming in for a fair inquiry, but nothing unusual has developed. *Bichromate of Potash.*—The market is more active, and supplies in second hands have diminished to the point where offerings are nominal. Manufacturers have advanced their price and as the time for taking contract business for 1918 is near at hand, the prospects are that the market will remain strong for some time. *Prussiates of Potash* are in big demand, and supplies are scarce. There is a noteworthy strength to the market on yellow prussiate in particular, and the Japanese product which has met with considerable favor here is only offered for future shipment from the Orient.

Copper Sulphate.—The market is not particularly active, and the demand is being taken care of with little trouble. One producer has lowered the price fractionally, but as a rule the market keeps steady.

Arsenic.—Offerings vary in price according to seller. There is a fair activity, but future positions are quoted at somewhat lower prices than for spot delivery and slight concessions are being made for nearby delivery as well.

The market for acids is, as a general rule, in a healthy condition; this is especially true of the mineral acids, the demand for which is wide.

Muriatic Acid.—Recent government purchases have established a firm tone for all grades, and producers in some cases have no supplies to sell at this time either for nearby delivery or futures. *Nitric Acid.*—On account of the high price of nitrate of soda, the market for this acid has increased considerably and prices are held strongly at the recently increased levels.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET AUGUST 23, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.27 —	.27½
Acid, acetic, 28 per cent	lb.	.05½ —	.06
Acetic, 56 per cent	lb.	.11 —	.11½
Acetic, glacial, 99½ per cent, carboys	lb.	.36½ —	.37
Boric, crystals	lb.	.13 —	.13½
Citric, crystals	lb.	.73½ —	.75
Hydrochloric, commercial, 18 deg	lb.	.01⅝ —	.01¾
Hydrochloric, 20 deg	lb.	.01¾ —	.01⅞
Hydrochloric, C.P., conc., 22 deg	lb.	.01⅞ —	.02
Hydrochloric, 30 per cent, in barrels	lb.	.04¾ —	.05
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.04½ —	.05
Nitric, 36 deg	lb.	.06½ —	.07
Nitric, 42 deg	lb.	.07½ —	.08
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 85 per cent	lb.	.35 —	.37
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3.50 —	4.00
Sulphuric, 60 deg	ton	24.00 —	26.00
Sulphuric, 66 deg	ton	30.00 —	35.00
Sulphuric, oleum (Fuming), tank cars	ton	40.00 —	45.00
Tannic, U. S. P., bulk	lb.	.45 —	.50
Tartaric, crystals	lb.	.81 —	.82
Alcohol, grain, 188 proof	gal.	4.30 —	4.35
Alcohol, wood, 95 per cent	gal.	1.00 —	1.02
Alcohol, denatured, 180 proof	gal.	1.00 —	1.02
Alum, ammonia lump	lb.	.04 —	.04½
Alum, chrome ammonium	lb.	.18½ —	.20
Alum, chrome potassium	lb.	.35 —	.40
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08 —	.08½
Aluminum sulphate, technical	lb.	.02 —	.02½
Aluminum sulphate, iron free	lb.	.03¼ —	.03½
Ammonia aqua, 26 deg. carboys	lb.	.12 —	.13
Ammonium carbonate	lb.	.13 —	.14
Ammonium nitrate	lb.	.16 —	.17
Ammonium, sulphate domestic	lb.	.07 —	.07¼
Amyl acetate	gal.	4.50 —	4.60
Arsenic, white	lb.	.16½ —	.17
Arsenic, red	lb.	.65 —	.65
Barium chloride	ton	85.00 —	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.11½ —	.12
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.02 —	.02½
Borax, crystals, sacks	lb.	.08 —	.08½
Brimstone, crude	ton	55.00 —	60.00
Bromine, technical	lb.	.80 —	.90
Calcium, acetate, crude	lb.	.03 —	.03½
Calcium, carbide	lb.	.08 —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.80 —	1.90
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	.01½ —	.02

Carbon bisulphide	lb.	.07½	—	08
Carbon tetrachloride, drums	lb.	.16½	—	16¾
Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.09	—	09¼
Chlorine, liquid	lb.	.15	—	.40
Cobalt oxide	lb.	1.60	—	1.65
Copperas	100 lb.	1.00	—	1.05
Copper carbonate	lb.	.32½	—	.35
Copper cyanide	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals	lb.	09¼	—	09½
Cream of tartar, crystals	lb.	.49½	—	.50
Epsom salt, bags	100 lb.	3 85	—	4 00
Formaldehyde, 40 per cent	lb.	.16	—	.16½
Glauber's salt	100 lb.	.75	—	.80
Glycerine, bulk, C. P	lb.	.64	—	.65½
Iodine, resublimed	lb.	4 50	—	
Iron oxide	lb	.02	—	.08
Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	12¾	—	.13½
Lead nitrate	lb.	17½	—	.18
Litharge, American	lb	07½	—	.08
Lithium carbonate	lb.	1 02	—	1.05
Manganese dioxide, U. S. P	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.16	—	16½
Nickel salt, single	lb.	.11	—	.11½
Nickel salt, double	lb.	.08	—	08½
Phosphorus, red	lb.	1.50	—	1.60
Phosphorus, yellow	lb.	2 25	—	2.50
Potassium bichromate	lb.	38½	—	.39
Potassium bromide granular	lb.	1 35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.50	—	.55
Potassium cyanide, 98-99 per cent	lb.	2 40	—	2.50
Potassium iodide	lb.	2 80	—	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330 00	—	340.00
Potassium nitrate	lb.	.29	—	.30
Potassium permanganate	lb.	3 85	—	4.00
Potassium prussiate, red	lb.	2 75	—	2.80
Potassium prussiate, yellow	lb.	1 08	—	1 12
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	325 00	—	350.00
Rochelle salts	lb	.39	—	.39½
Sal ammoniac, gray gran	lb	10½	—	.11
Sal ammoniac, white gran	lb.	16	—	.16½
Sal soda	100 lb.	1 20	—	1.25
Salt cake	100 lb	1 10	—	1.15
Silver cyanide	oz.		—	
Silver nitrate	oz.	49⅞	—	.50⅞
Soda ash, 58 per cent, light, flat	100 lb.	3 85	—	4.00
Soda ash, 58 per cent, dense, flat	100 lb.	3 90	—	4.00
Sodium acetate	lb.	.10	—	.10½
Sodium benzoate	lb.	2 75	—	3.00
Sodium bicarbonate, domestic	100 lb.	2 35	—	2.50
Sodium bicarbonate, English	lb.		—	
Sodium bichromate	lb.	.16¼	—	.16½
Sodium bisulphite, powd	lb.	04	—	.04½
Sodium chlorate	lb.	23	—	.25
Sodium cyanide	lb.	52	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	01¾	—	.02
Sodium nitrate, 95%	100 lb.	4 30	—	4 35
Sodium nitrite	lb.	.45	—	.50
Sodium peroxide	lb.	.75	—	.80
Sodium phosphate (tri.)	lb.	.05	—	.05¼
Sodium prussiate, yellow	lb.	.32	—	.33
Sodium silicate, liquid —40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3.10
Sodium sulphide, 60 per cent, fused	100 lb.	4 50	—	4 55
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	3 20	—	3 30
Sulphur, roll	100 lb.	2 55	—	2 60
Sulphur, crude	ton	45 00	—	50 00
Tin bichloride, 50 deg	lb.	19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.10¾	—	.11
Zinc cyanide	lb.	.50	—	
Zinc dust 350 mesh	lb	17	—	.19
Zinc oxide, American process XX	lb.	15½	—	.16
Zinc sulphate	lb.	.05½	—	.06

Coal Tar Products (Crude)

Benzol, 1 to 5 water white	gal.	.51	—	.53
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	1.75	—	1 80
Xylol, pure, water white	gal	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal	.31	—	.33
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb	1 00	—	1 05
Carbolic acid, crude, 50 per cent	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent	lb	.32	—	.35
Cresol, U. S. P	lb.	.25	—	

Intermediates, Etc.

Alpha naphthylamin	lb.	.70	—	.75
Aniline oil	lb.	.27	—	.28
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	
Benzaldehyde	lb	1 00	—	4 50
Benzidine, base	lb.	1 85	—	2 00
Benzidine, sulphate	lb.	1 55	—	1 60
Benzoic acid	lb.	2 75	—	3 00
Benzyl chloride	lb.	1 75	—	2 00
Beta naphthol benzoate	lb.	8 50	—	9 00
Beta naphthol, sublimed	lb.	85	—	.90
Beta naphthylamin com	lb.	2 50	—	
Dichlor benzol	lb.	.11	—	.20
Dinitrochlorbenzol	lb	.44	—	.46
Dimethylaniline	lb.	.58	—	.60
Diphenylamine	lb.	1 00	—	1 05
H-acid	lb.	3 50	—	4 00
Metaphenylenediamine	lb	1 75	—	1 80
Monochlorbenzol	lb	.22	—	.23
Naphthalene, flake	lb	.09	—	09¼
Naphthionic acid, crude	lb.	1 50	—	1 75
Nitro naphthalene	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lo			
Ortho-toluidine	al	.90	—	1 00
Para-amidophenol, base	c.	4 00	—	5 00
Paranitraniline	lb.	1 05	—	1 10
Paraphenylenediamine	lb.	3 75	—	4 00
Para toluidine	lb.	2 00	—	2 10
Phenol, U. S. P	lb.	.41	—	.42
Resorcin, technical	lb	8 00	—	9 00
Resorcin, pure	lb.	15 00	—	16 00
Salicylic acid	lb.	1 50	—	1 60
Salol	lb.	1 85	—	2 00
Sulphanilic acid	lb.	.32	—	.33
Tolidin	lb.	3 00	—	
Toluidine mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3 25	—	
Corning, Ohio	bbl.	2.50	—	
Somerset, Ky	bbl.	2 30	—	
Wooster, Ohio	bbl.	2.28	—	
Indiana	bbl.	1 88	—	
Illinois	bbl.	2 02	—	
Oklahoma and Kansas	bbl.	1 90	—	
Caddo, La., light	bbl.	1 90	—	
Corsicana, Tex., light	bbl.	1 90	—	
California	bbl.	98	—	1 32
Gulf Coast	bbl.	1.00		

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13½		14
Cylinder, light	gal.	21	—	.26
Cylinder, dark	gal.	18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.55
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.33½	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	19	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	
Wood creosote, tel	gal	.30½	—	

Vegetable and Other Oils

China wood oil	lb.	.19	—	.19½
Cottonseed oil, crude	gal.	1.02	—	
Linseed oil, raw, cars	gal.	1.24	—	
Peanut oil, crude	gal.	1.17	—	1.20
Rosin oil, first run	gal.	.35	—	
Rosin oil, fourth run	gal.	.66	—	
Soya bean oil, Manchuria	lb.	.14	—	14½
Turpentine, spirits	gal.	.42	—	

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	28.00	—	32.00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, flor	lb.	.53	—	
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12 00
Fuller's earth, powdered	100 lb.	1.00	—	1 50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	
Rosin, 280 lb	bbl.	6.00	—	
Soapstone	ton	10.00	—	12 50
Talc, American, white	ton	10.00	—	13 00
White lead, dry	lb.	.11½	—	

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50 00	—	55 00
Clay brick, second quality	per 1000	35 00	—	40.00
Magnesite, raw	ton	30.00	—	35 00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85 00		90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135 00		140.00
Silica brick	per 1000	50 00	—	60 00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160 00	—	
Ferrochromium	lb.	.20		
Ferromanganese, domestic, delivered	ton	375 00		400 00
Ferromanganese, English	ton	375 00	—	
Ferromolybdenum, per lb. of Mo	lb.	4 00		4 40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225 00		250 00
Ferrosilicon, 50 per cent, contract	ton	100 00		
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2 60		2 65
Ferromanganese, f.o.b. works, per lb. of U	lb.	7 00		
Ferrovanadium, f.o.b. works	lb.	3 25	—	3 50

Ores and Semi-finished Products

Molybdenite, per lb. of MoS_2	lb.			2 10
Tungsten, Scheelite, per unit of WO_3	ton			26 00
Tungsten, Wolframite, per unit of WO_3	ton			25 00
Uranium oxide, 96%	lb.	3 25	—	3 50
Vanadium Pentoxide, 99%	lb			11 00

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The American & Foreign Paper Corp. To manufacture paper and paper products. Incorporators are J. H. Bardsley, A. Isaacson, B. H. Rohrey, 259 Broadway.

American Electrothermic Smelting Corp., Manhattan. $100,000. General mining business. M. F. Connor, Jr., F. A. Collins, J. L. Covey, 568 West 149th Street.

Belleville Metal & Chemical Co., 241 Cortlandt Street, Belleville, N. J. $50,000. To manufacture chemicals.

The Big Lake Oil & Gas Company. $100,000. Incorporators are Burton E. Green, M. H. Whittier, William G. Kerckhoff, H. L. Westbrook and F. B. Sutton.

Bruner Chemical Company, Perth Amboy, N. J., manufacture chemicals; capital, $10,000. Incorporators: Willard L. Bruner, Perth Amboy; Leidy S. Bruner, Lansdale, Pa.; J. Norman Bruner, Philadelphia.

The Chemical Alliance of New Haven. Incorporators are James F. McClelland, Walter S. Ferris and Harrison T. Shelton.

Chillicothe Cotton Oil Company, Chillicothe, Tex., $125,000. Incorporators are C. E. Carter, W. L. Campbell, Jr., and Richard T. Harris.

F. A. Dillingham, Inc., N. Y. City; drugs and chemicals; 100 shares preferred stock $100 each, 4000 shares common stock no par value, active capital $30,000. Incorporators: A. B. Champlin, F. A. Dillingham and R. P. Ballard, 17 West Forty-second Street.

The Fairfield Pure Water Corp., $225,000. To manufacture, design, etc., filtration and distillation plants, manufacture alkalies, chemicals, smeltings, etc., of metal. Incorporators are L. H. Moore, Broadway and Seventy-second Street, New York City, N. Y. V. R. Neil, 26 Dock Street, Yonkers, and M. Rogers, 426 Twelfth Street, West New York, N. J.

The Fort Smith Glass Products Company, Little Rock, Ark., $46,000. To manufacture high grade glass products. Incorporators are Charles Becker, president; George L. K. Hammons; vice-president, C. A. Frederich; secretary-treasurer, Herman Schuchnact, Robert Malcom, and E. D. Holmes. All are residents of Chicago except Mr. Frederich, who lives in Little Rock.

Hamburg Foundry Company, Hamburg, Pa., $50,000. Incorporator, D. H. Redmond, Philadelphia.

The Imperial Machine & Foundry Corp., Manhattan. $300,000. To manufacture metals, mill supplies and machinery. Incorporators are H. Robinson, 108 West Thirty-fourth Street; J. G. Abramson, R. A. Abramson, 30 Church Street, New York City.

The Kaolin Refining Company, Spokane, $100,000. Happy & Happy.

Lincoln Chemical Works, Lincoln, N. J., manufacture chemicals. Capital, $10,000. Incorporators: Nat S. Kallmann, Long Branch; Hyman Beler, Morris Katz, Brooklyn.

McKeesport Enameling Co., McKeesport, Pa. To manufacture paints, enamels and varnishes. Capital, $50,000. Incorporators: James W. Nesbit, A. Clifford Wiltshire and J. R. Worley, McKeesport, Pa.

M. B. Manufacturing Corp., Manhattan, $5,500. To manufacture and deal in chemicals. Incorporators are N. Lazarus, A. Phillipe, A. Romeo 5000 Broadway.

Mackay System, Inc., New York, $12,500. To manufacture chemicals, dyes, paints, and carry on general paint business, 2500 shares common stock, no par value. Incorporators are H. A. St. George, E. A. Darr, V. H. Vreeland, 41 Park Row.

Marvelo Detergent Company, Chicago. $1,000,000.

The Mathieson Alkali Works, Inc., Virginia, $2,000,000. To manufacture salt, soda, bleaching powder, and chemicals. Representative, F. B. Richards, Buffalo.

The Merchants Steel & Supply Company of Chicago. $50,000.

The National Concrete Products Company, $50,000. Incorporators are E. B. Blinn, Henry Barkschat, E. J. Pyle, William C. Crowell and Leo D. MacLaughlin.

National Rolling Company, Vincennes, Ind. $300,000.

Natural Dye Woods, Ltd., N. Y. City; importing and exporting and general realty agents; capital, $10,000. Incorporators, F. W. Will, G. H. Boyce and T. H. Phillips, Jr., Essex Street, Brooklyn.

Neptune Chemical Corporation, Brooklyn, $5,000. Incorporators are Herman Finkelstein, Katie Finkelstein, Edward L. Petow.

Nitrogen Fixation Corporation, Manhattan. $1,000,000. Chemical manufacturing. Incorporators, Josef F. A. Comstdet, J. Robert Rubin, Sidney M. Weil.

Ontario Smelting Company, Wilmington, Del., $250,000. Incorporators are M. L. Gatchell, L. A. Irwin, Harry W. Davis.

The Pacific Potato Starch Company, Portland, Ore., has been organized, with capital stock of $65,000, to manufacture by-products from potato culls. Machinery will be installed immediately in a new plant to be built here. Company is formed by L. W. Cronan of Portland, and J. E. Cronan and associates of Ione, Ore.

The Perkiomen Paper Mills Co., of Pennsburg. Incorporators are Chas. Q. Hillegass and L. S. Jacoby.

Peru Foundry Company, Peru, Ind., $60,000. General foundry business. Incorporators are M. F. Gartland, J. H. Schaumleffel, P. V. Gartland, Frank X. Gartland, John C. Haswell, John P. Whalen, Harry J Schaumleffel.

The Petroleum Products Company, Franklin, capital $50,000. Incorporators are John F. La Rue, J. Nall La Rue and J. C. Parson.

The St. Lawrence Metal Products Corp., $200,000. To manufacture metal wood and chemical products. Incorporators are E. J. Furley, Montreal, Canada, P. N. Fitzgibbons, 102 Washington Street, Ogdensburg, and J. E. Fell, 44 New York Avenue, New York City, N. Y.

The Silver Hill Mining Company, Spokane, Wash., has been incorporated for $150,000 by B. W. Dunn, C. J. McDonald and C. W. Greenough.

U. S. P. Salicylic Co., Inc., Manhattan. $50,000. To manufacture acids, chemicals, etc. Incorporators are V. E. Gartz, 60 Wall Street; A. Golden, Times Building, E. W. Kluchansky, New York.

Uintah Basin Producing and Refining Company, $3,000,000. To drill and operate for petroleum, oil and gas. Incorporators are F. D. Wise, C. A. Campbell, J. P. Koehler, Indianapolis, Ind.

The Valley Steel Co., organized several months ago under the laws of New York to build and operate a $1,000,000 steel mill in Milwaukee, which now is under construction at St. Francis, near Milwaukee, has been reincorporated under the laws of Delaware, with the new name of General Steel Co. The new corporation has 13,000 shares of preferred stock, each with a par value of $50, and 16,000 shares of common stock with no par value.

The West Kentucky Zinc & Smelting Co., Crittenden County, Ky. $2,500. To operate a zinc mine. Incorporators are B. D. Hill, Lee Oldham, F. M. Brown and J. W. Downer.

West Rutherford Color and Chemical Company, Inc., Manhattan. $7,500. To manufacture chemicals, colors and dyes. Incorporators are Frederick J. Saccomani, Joseph Brietenstein and Agnes Dolan.

J. F. White & Co., Inc., New York. $1,000,000. To manufacture jute, flax, cotton, hemp, wood pulp, paper goods and dry goods. Incorporators are H. D. Cooper, H. A. Murphy, W. S. Kimball, 54 Worth Street.

Construction and Operation

Arizona

DOUGLAS.—Attorney D. A. Richardson of Douglas has announced that he has organized a company to build two tanning plants, one for Douglas and the other for Agua Prieta. They will cost $10,000 each. W. C. Humphrey, a well known mining man, is associated with him in the enterprise.

TUCSON.—A carbonate leaching plant, similar to that at Ajo, is planned for the Twin Buttes section, south of this city. The Magnate Copper Company has twenty-nine claims on which the surface ores are believed susceptible to leaching.

Hughes & Dier of Philadelphia, who are backing the enterprise, are understood to have indicated that $5,000,000 will be available for construction of suitable works in the event a favorable report is given by Walter Harvey Weed, who has been placed in general charge. Development of the company's property has been commenced with churn drills on a sixty-acre tract, in which concentrating ore already has been developed. Some richer ore now is being shipped to El Paso.

A matting furnace is planned by the Duquesne Mining & Reduction Company to further reduce concentrates now being shipped.

At Cananea the Carnegie Lead & Zinc Company is preparing to spend $400,000 on a new mill and provision of railroad service. The concentrator will have capacity for 500 tons of ore a day, and will be equipped with flotation, to better the present extraction of only 80 per cent. J. H. Sanford, Jr., is in charge of the mine. R. P. Burgan was elected president at the last meeting.

TUCSON.—Announcement that New Cornelia will erect a 5000-ton flotation plant and a 2000-ton smelter at Ajo as the result of the purchase of the Ajo Consolidated property was made in Tucson recently by Captain John C. Greenway, general manager of Calumet & Arizona and New Cornelia.

The big flotation plant will be ready for operation in two years. It will produce 750 tons of concentrates daily, which will be sent to the smelter.

California

SAN FRANCISCO.—A San Francisco firm has been awarded the contract for the construction of the new unit of the California-Hawaiian Sugar refinery at Crockett. The exact price was not given, but it is estimated that the job will cost about $2,500,000. Work will be started at once and at the same time the reclamation of the tidelands in the vicinity of the refinery will be begun. When the reclamation work is finished it will be possible for the company to place the large warehouses and wharves so that ships may tie up to them and unload.

SANTA ROSA.—The rebuilding of the big Vallejo plant of the Santa Rosa-Vallejo Tanning Company, which was recently destroyed by fire, is to be undertaken at once, according to an announcement by the company's officials.

Connecticut

NEW BRITAIN.—The American Hardware Corporation having obtained authority from the Public Utilities Commission to construct a spur track through Bigelow Street, it is expected that work will be commenced soon upon a new foundry building there to replace the annex recently destroyed by fire

NEW HAVEN.—The Magnus Company, Inc., has taken out a permit from Building Inspector Austin's office for a foundry, 40-50 Eddy Street, to cost $50,000.

Florida

ST. PETERSBURG. The utilization of shark skins in producing leather will become a Florida industry, if the announcement of J. F. Lavarne of Pittsburgh of a $300,000 plant at St. Petersburg is realized. Mr. Lavarne has been experimenting on tanning shark skins and handling all kinds of fish by-products for years.

Mr. Lavarne has organized the Universal By-Products Company of Pittsburgh, Pa., of which he is president, and proposes the enlargement of a plant in Alaska, where the operations have been carried on, the building of another plant at Seattle, Wash., to cost upwards of $300,000, and another plant at St. Petersburg costing approximately the same amount. It is his expectation to start work on the St. Petersburg plant this winter, and plans are being drawn.

Idaho

KELLOGG.—The first shipment of crude lead produced by the Bunker Hill & Sullivan Mining & Concentrating Company has left the smelter destined for Pennsylvania. Its value was $10,000. Shipments will be made regularly from now on.

Illinois

CHICAGO.—The Eastern Metal Refining Company has leased land on Fiftieth Street, between Fifth and Princeton Avenues, and will erect other improvements at a cost of $20,000.

PEORIA.—A large malleable foundry, in which a large amount of Peoria capital is invested, is to be located in Averyville in the near future.

The company has purchased a strip of ground below the C. R. I. & P. tracks and between the United Box Board Company and the Avery Company grounds, and the preliminary work toward constructing a large up-to-date foundry will be started at once.

Kentucky

LOUISVILLE.—A $500,000 oil refinery that will have an immediate capacity of 2500 barrels daily is to be erected at once by the Aetna Refining Company on forty acres of ground, located on Gibson's Lane near the State fair grounds, that company officials purchased recently from Mrs. C. C. McClarty.

Oil from Kentucky fields will be handled almost exclusively in the petroleum plant. The oil will be brought in barges down the Kentucky River from the so-called Estill County district. It is announced the refinery will have an ultimate capacity of 4000 barrels daily. Fifty men will be employed as soon as the plant is opened and about 100 employees will be on the payroll when the refinery is ready to run "full force," it is said.

Louisiana

SHREVEPORT.—The Western Carbon Company, a subsidiary of the Columbian Carbon Company, is erecting a carbon plant at Cedar Grove, near here, to cost about $125,000, with capacity of 100 barrels daily, to be in operation in 60 days, using natural gas.

Maryland

BALTIMORE.—Extensive plans for the renovation of the plant of the Curtis Bay Chemical Company, at Stone House Cove, Anne Arundel County, which ceased the manufacture of acetone about Aug. 1, and which discharged more than half of its employees perparatory to closing, are being rushed to completion, and when improvements are completed it may be that more men will be employed than heretofore and that the output will be of much greater value than the former acetone output. Already, it is known on good authority, that potash has been successfully manufactured from molasses refuse obtained at the plant of the Curtis Bay Distillery, at Curtis Bay, a branch of the United States Industrial Alcohol Company of New York which has been turning out thousands of barrels of alcohol monthly. Aside from this important product, important oils, greases and animal feed are to be turned out.

Minnesota

DULUTH.—The Minnesota Steel Company will expend $2,000,000 on new construction at the Duluth plant this year, and next year will begin the construction of the second furnace unit of the plant, involving the expenditure of several millions of dollars.

Advices were received in Duluth from the New York headquarters of the United States Steel Corporation that two blast furnaces and four open hearth furnaces, costing $1,500,000, would be built as soon as plans can be completed and contracts let, completing the first unit of four blast furnaces and fourteen open hearth furnaces.

Work has been started on the erection of a benzol plant which will cost about $500,000.

MINNEAPOLIS.—The Northern Welding Company has sold its Minneapolis plant and Duluth branch, the Duluth Gas Company, to the Air Reduction Company of New York. The transaction involved $400,000.

The Minneapolis plant is at this time making welding equipment for the Government.

Montana

HELENA.—It is stated that representatives of Pennsylvania steel mills have been looking over ground in Granite County, near here, with a view of erecting a large smelter for reduction of manganese ore, and with a possibility of steel mills being erected in Montana. The manganese now being mined in Granite County is mixed with the iron from iron deposits found in other parts of the state.

BUTTE.—The Butte-Detroit Mill will be in shape early in August to handle 200 to 400 tons manganese ore daily. Changes in machinery at the "front end," where the crushers and jigs are located, are now under way. Mill will be operated as a custom plant, and will be the only mill in Butte handling manganese ores.

WINDY GAP.—The Montana Tungsten Company has struck very rich tungsten ore near this city, and will install machinery for sinking shafts and install a mill.

New Jersey

MILLVILLE.—The largest glass plants in Millville closed their blast for the summer stop July 28, and almost all of the 4000 glass workers who have been working here for the last eleven months will enjoy a five weeks' vacation. One furnace remains in operation at the T. C. Wheaton Company glass works and one at the Millville Bottle Works.

Extensive improvements will be made at all the works during the idle period, and it is reported that at least two new factories will be built and put into full operation in the early fall. The wages made by the tending boys throughout the season has exceeded by far any wages ever before paid to them in the history of the glass industry.

NEWARK.—The Orr Chemical Company has leased the one-story concrete block building and several smaller structures at 344 Thomas Street, for the manufacture of valerianic acid.

New Mexico

SANTA FE.—The 100-ton smelter that is being erected by the Sandoval Consolidated Copper Company in the Nacimiento Mountains, 60 miles west of Santa Fe, is completed and is to start operations shortly. The ore will come from twenty-eight claims formerly managed by Prof. William Jenks and which produced almost 5,000,000 lb. of copper.

New York

BUFFALO.—A steel and brick coal house, covered scrap yard and an electric furnace will be erected by the Sizer Forge Company at 238 Larkin Street at a cost of $109,500, according to building plans filed by the company.

North Carolina

GREENSBORO.—Swift & Co. has begun work on the site for the fertilizer factory just south of Greensboro. The contract for the building is in the hands of A. D. O'Brien, of Wilmington.

WASHINGTON.—The Virginia-Carolina Chemical Company in the near future will erect a fertilizer factory with an annual capacity of 40,000 tons at Washington, N. C. Owing to the increased difficulty of obtaining necessary supplies, earnings derived from fertilizer during the past year have not been as great as at first anticipated, although they have been satisfactory.

WILMINGTON.—Old North State Pulp & Paper Mills, which heretofore has manufactured only pulp from North Carolina timber, has increased its capital stock to $2,000,000 and will go extensively into the manufacture of paper. The present plans call for the immediate building of a paper mill which is to have a daily capacity of 100 tons. The company has purchased the site for the new mills, and will start work on the same at once.

Oregon

CULVER.—Word has been received here from C. F. A. Pock, who has been in New York for some time financing the gas smelter to be built between Culver and Crooked River Rim, that he has been successful and the smelter will soon be started

GOLD HILL.—O. M. Raseau of Seattle, representing iron ore interests, has inspected the iron ore deposits at Gold Hill, and has found sufficient magnesite blended with hematite-magnetite iron ore deposit to make a good ferro-manganese base. As soon as extent of deposit has been determined, shipments will be started.

OREGON CITY.—The Crown Willamette Paper Company has announced a voluntary decrease in the hours of labor at its plant from ten to nine hours, with ten hours' pay.

PORTLAND.—Ore shipments to the new blast furnace that is to be started at the Oswego, Ore., plant of the Pacific Coast Steel Company, will start early in October from the iron ranges of San Bernardino County, California. About 400 tons a week will be delivered with gradual increase until at the end of two years, it will reach 10,000 a month. Under the same contracts ore shipments will move to the company's furnace at Irondale, which will be blown in within the next few weeks.

Pennsylvania

ALLENPORT.—The Pittsburgh Steel Products Company, which has a large plant at Monessen, Pa., for the manufacture of seamless steel tubes, plans to build new works at Allenport, opposite Monessen, on the Monongahela River, where it owns about 300 acres. This plant will probably be larger than the Monessen plant. The capacity of the Monessen plant is 60,000 tons seamless steel tubes per annum.

POTTSVILLE.—The owners of the Eastern Steel Company of this city, in which New York capitalists have invested about $9,000,000 during the present year, are to make improvements, extensions and concentration at the mammoth works, which will mean an increase of more than 33 per cent in the present finished, wrought and steel billets production annually. A steel converter or melting pot is among the new machinery to be installed. The increase was found a necessity, because the present output is not sufficient to keep all the rolling departments supplied to their capacity.

READING.—The Temple Malleable Iron & Steel Company, operating a plant at Temple, has announced plans for a brick, steel and concrete foundry to cover seven acres and to cost $500,000 with equipment.

Tennessee

MEMPHIS.—While cotton is still king in the South, the peanut promises to dispute or to share its dominion in some sections as part of well-balanced farming practice. The State of Texas, for example, has planted 600,000 acres to peanuts, more than doubling the acreage of last year, according to figures just issued by the United States Department of Agriculture. The prospective crop, on the same authority, is more than 70,000,000 bushels for the whole South. Texas already had the largest acreage in 1916, though in 1909 it stood sixth, with most of the Atlantic and Gulf Coast States ahead. Georgia jumped from 190,000 acres last year to 420,000. The increase in Texas has been an index of the increase throughout the lower South, though the proportionate increase elsewhere has not been so great. For the South as a whole, however, it is remarkable that the acreage has increased from less than a million and a quarter acres to more than two million acres. Practically no peanut oil was made in this country prior to 1915, and so far the oil mill men had not been benefited; but it was brought to their attention that the United States, in 1914, was importing 1,332,108 gal. of peanut oil and 44,549,789 lb. of nuts. More than half of the oil went to Chicago and presumably went into oleomargarine and the lower grades into soap. The oil brought more than cottonseed oil. A few changes in the oil mills, having to do largely with the cleaning of the peanuts, and they were ready for the extraction, and the peanuts began to come to them. Recently there has been such a demand for the nuts themselves, for manufacture into products elsewhere, that the mills have not been doing much extraction because they could make more handling the nuts themselves than they could by selling the extracted product

Texas

HOUSTON.—A plant for the manufacture of absorbent cotton and the conversion of cotton linters into artificial silk is planned here by Frederick Wide of London, England, representing British capitalists. Mr. Wide, who is here from New York, went down the channel as the guest of Benn Garrett, president of the Pan-American Trading Company, from whom he has secured his location. He will build his plant immediately west of Industrial City, adjoining the Pan-American Company's shipyards, and will occupy 200 ft. of water frontage. He has already authorized construction of his first unit, 60 x 100 ft., and has assembled most of his machinery in Philadelphia. To expedite work he has contracted with the Pan-American Company to supply all needed brick. The company will use its own clay deposit, burned in its own kilns. Construction of the kilns began Wednesday morning. They will be built on Greens Bayou, the westernmost boundary of the Pan-American tract, and will have a capacity of 150,000 bricks. Fuel to keep the kilns going will also come off the site. Wood fuel will be used. In 90 days the Wide plant will be in operation, turning out 1000 lb. of absorbent cotton daily for Great Britain

Utah

IDAHO FALLS.—By a deal closed recently in Salt Lake by Dr. H. A. Anderson of Rigby, Idaho, the Beet Growers Sugar Company acquired title to a plant in the outskirts of the town of Rigby. Dr. Anderson, chairman of the executive committee of the company and formerly county physician of Salt Lake County, announced last night that plans for the erection of the plant would be prepared at once, the contract let, and work started on the factory within the next sixty days, with a view to having everything in readiness for handling the 1918 sugar beet crop. The general offices of the company are located at Idaho Falls, but a branch office, under the charge of Treasurer H. F. Aller, has been opened at 307 Dooly Building, Salt Lake.

Washington

ABERDEEN.—The Thomas Pulp & Paper Company of Portland has selected Aberdeen as the site of its proposed big pulp and paper plant, according to R. Thomas, president. The company has purchased 300 acres of coal land and will mine its own coal, 300 tons of which will be used daily. Thomas is inventor of a process to make paper out of fir as well as spruce.

CHEWELAH.—The Northwest Magnesite Company shipped 189 carloads of magnesite from Chewelah during July, according to report by the company. It is expected that increased shipments will be made as development proceeds, and means of transportation are increased. The company is progressing with installation of its plant which will be used to manufacture magnesite products.

LEAVENWORTH.—The Lahnigan Company of Butte, Mont., has recently purchased a square mile tract near this city, on which it is rumored a smelter is to be erected. Tremendous quantities of marble close by is expected to furnish lime.

SEATTLE.—The Eagle Brass Foundry has let contract for two-story, 90 x 105 ft. mill construction factory building, to cost $10,000.

SPOKANE. — The Muscovite Mining Company here is busy turning out "eyes" for gas masks for soldiers, to be used in France, "windows" for heating stoves, and all kinds of transparent squares, circles and rectangles. Company owns mines in Idaho, and the cutting plant in Spokane has been in operation only a few weeks. To meet the demand that has already developed the company plans to install new machinery, including a grinder, to be used in working up the scraps and waste from the blocks and sheets of mica into powder to be used in manufacture of lubricants, roofing material, wall paper, fireproof paints, etc. Dr. H. E. Elliott of Spokane is president of the company.

SPOKANE.—The Spokane Acetylene Gas Company plans to extend the scope of its activities by financing the company and constructing a big plant in Spokane. The present plant is inadequate to meet the demands of the automobile accessory houses and welding plants in the city. It is estimated that there is a demand for more than 45,000 cu. ft. of acetylene gas in Spokane a month.

SPOKANE.—The U. S. Magnesite Company, organized July 3, has started shipping magnesite. The product is consigned to the Hillyard plant of the American Brick Company for manufacture into ferro-magnesite brick.

SPOKANE.—The American Wood Products Company here, is to be reorganized by H. J. Earnst and Eastern associates. The capitalization will be increased to $1,000,000, and a manufacturing plant, operating on a large scale, will be established in Spokane. Plant will produce turpentine, pine oil, light and heavy oils, charcoal, creosote and coal tar products. Purchase of extensive timber lands is also planned.

SPOKANE.—The C. G. Betts Company, makers of coal tar products, with a factory at Erie and Railroad Avenues, plan to add to their line the manufacture of napthalene flakes. Machinery for the recovery of this material from coal tar is now being installed, and will be in operation within 30 days. For a number of years the company has been utilizing coal tar from the Spokane Gas Works, in the production of creosote, roofing and paving tar, and preservative paint for metal and wood. The company's output has recently found a new demand in the mining enterprise near Spokane, for selective ore flotation, and the company is now using from 40,000 to 50,000 gal. of coal tar per month in its manufactures.

SUNNYSIDE.—The Potato Growers Association of Yakima Valley has indorsed the starch factory project in that city, and it is expected that work will start shortly.

TACOMA.—The Tacoma smelter of the American Smelting & Refining Company has gone on a straight 8-hr. day basis, with 9 hr. pay.

TACOMA.—The L. Y. Stayton Cement Pipe Factory here is being extended to double its present capacity. The plant has so many orders on its books that it is compelled to run 24 hr. a day. New improvements include building 70 x 200 ft., and 50 x 250 ft. extensions to either side of the main building, with installation of much new machinery. Concern is now working on contract for 60,000 ft. 24 and 30-in. concrete pipe for the American Lake cantonment. Company has shipped pipe to all parts of Washington and Alaska, and handles big government contracts. Plant is equipped to turn out pipe from 4 to 36 in. in diameter. The plant has been operating in Tacoma for more than 12 years.

WILKESON.—The 60 new coke ovens of the Wilkeson Coal & Coke Company here have been completed and placed in operation. The new ovens make a total of 160 ovens operated by the company. It has taken a crew of 20 men more than six months to complete the work, sandstone being used extensively.

Ontario

HAMILTON.—The Semet-Solvay Company has engineers reporting on a project to erect a $2,000,000 coke oven plant. The plant will be erected by the Hamilton By-Products Coke Ovens, Ltd. It will have a capacity of about 900 tons of coke a day, and 7,000,000 ft. of gas. Stypes inlet is the site that has been chosen.

Manufacturers' News

BIG CONSOLIDATION.—Plans are being completed for the consolidation of the National Carbon Company, the Union Carbide Company, and the Air Reduction Company, according to information obtained in banking circles. A new company will be formed, whose stock will be exchanged for the shares of the three corporations. The new organization is expected to have authorized capital stock of $150,000,000.

The Union Carbide Company has outstanding $20,966,600 stock, which, at the current market price of approximately $200 is worth close to $42,000,000. The National Carbon's outstanding capital consists of $9,965,000 common and $5,000,000 preferred, with a current market value in the neighborhood of $13,000,000. The Air Reduction Company has 125,000 shares without par value, which at 97 would be appraised at $12,125,000. The total for the three companies would be around $67,000,000.

The concerns make allied products. The Air Reduction Company was formed about a year ago to make oxygen and nitrogen from the atmosphere by the Claude process and also to manufacture equipment for welding metals.

PAPER-PULP PLANTS WANTED.—Communications have been received by the Forest Products Laboratory of the Forest Service from the Technological Museum of New South Wales, at Sydney, Australia, and from the Forest Research Institute of India, asking for plans and specifications and estimates of cost of experimental paper-pulp plants.

Mr. Richard T. Baker, curator of the museum at Sydney, states that an investigation of the pulping qualities of Australian hardwoods has been undertaken, and he desires to communicate with manufacturers of needed machinery. His address is: The Technological Museum, Harris Street, Sydney, New South Wales, Australia.

Mr. William Raitt of the Forest Research Institute and College of India, states that the branch of the service that he represents is contemplating a large extension of its practical work and that the installing of a plant for the production of paper pulp is among the projects undertaken. He desires illustrations and descriptive matter on the subject and invites estimates from manufacturers. He favors a drying machine on the Fourdrinier principle, but with no shake on the wire. The raw material to be used comprises bamboo and Savannah grasses digested by the soda method. The institute also intends to fit up small plants for the treatment of resins, gums, etc., cracking of oils, tanning extraction, and timber creosoting. Mr. Riatt may be addressed at the Forest Research Institute and College, Dehra Dun, United Provinces, India.

CAPITALIZATION OF NEW CHEMICAL COMPANIES.—The authorized capital of new companies formed in July for the manufacture of chemicals, drugs and dyes amounted to $10,215,000, according to a special compilation of The Journal of Commerce. This figure shows a marked increase from the total for June, which was $1,175,000, and has been exceeded in only five months since the beginning of 1915. The aggregate authorized capital of similar concerns organized in July, 1916, was $330,000 and in July, 1915, $4,950,000.

The total indicated investment in chemical, drug and dye corporations during the last thirty-one months, covering the period since importations from Germany have been cut off and the United States has been forced to depend largely upon domestic production of materials, is $217,569,000. Of this total, $52,760,000 represents companies organized in the first seven months of 1917. The average monthly authorized capital of these companies to date this year is $7,537,143, which compares with a monthly average during 1916 of $8,270,333, and during 1915 of $5,463,750.

FIRE PREVENTION.—The National Board of Fire Underwriters, 76 William Street, New York, has prepared for the Council of National Defense, and are mailing to a list of some 66,000 of the leading manufacturers of the United States a booklet of directions for the prevention of fire, under the title of "Safeguarding Industry," together with a show-card of fire prevention rules for employees.

This matter represents considerable labor and large expense. Its purpose is the highly important one of preventing fires in industrial plants which are working under the abnormal conditions of wartime emergency. President Wilson has given a signed statement for the cover of the booklet, as follows:

"Preventable fire is more than a private misfortune. It is a public dereliction. At a time like this of emergency and of manifest necessity for the conservation of national resources, it is more than ever a matter of deep and pressing consequence that every means should be taken to prevent this evil."

SARCO COMPANY, INC., of New York, have received orders for Temperature Regulators for each of the sixteen cantonment camps, as well as for the Selfridge Aviation Field, near Mount Clemens, Mich., and for the League Island Navy Yard at Philadelphia, Pa.

PSYCHROMETRIC CHART.—The Braemer Air Conditioning Company, Philadelphia, Pa., has prepared for distribution a psychrometric chart which should prove very useful in dealing with humidity and evaporation problems. The chart shows by curves relative humidity, dew point, absolute humidity, total heat per pound of air, volume per pound of air, and vapor pressure.

ELECTRIC FURNACES.—T. H. Watson & Company, Ltd., of Sheffield, England, who control the patents of the Greaves-Etchells electric furnace, announces the formation of an American company to handle the furnace business in the United States and Canada. The new company will be known as the Electric Furnace Construction Company, with head offices in the Finance Building, Philadelphia.

The American Company have just received awards for 6-ton equipments, to be installed in the United States Navy Yards at Puget Sound, Norfolk and Honolulu.

Mr. Frank Hodson, a partner of the T. H. Watson & Company, is now in this country to arrange the details of the new company, and will act as its president. Mr. J. Ryan will be general manager. Mr. Ryan resigned as eastern manager of the Snyder Electric Furnace Company on June 1 to take up his present duties.

EIGHT HUNDRED MESH SCREENS.—Whenever very fine material was desired, material finer than 200 mesh, resource had to be taken to bolting cloth. Stearns-Rogers of Denver, Colo., is at present putting out a metal screen which will handle material as fine as 800 mesh. Ordinary 200 mesh screening is electroplated with nickel In this manner 300, 400, 500 up to 800 mesh openings may be obtained by simply regulating the amount of nickel deposited. It is claimed that the deposit of nickel gives a hard and lasting surface, the only drawback being that the material is rather brittle. Some careful regulation of the conditions required in the electroplating operation will undoubtedly overcome this evil, as rather ductile deposits of nickel can be obtained in practice. These screens should prove of value in flour mills and in such metallurgical operations where the values lost are usually found in the very fine material, as for instance in the losses encountered in the metallurgy of tungsten ores where 66 to 80 per cent of all the losses are found in the materials finer than 200 mesh.

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The Chemical Exposition

The third National Exposition of Chemical Industries, to be held at the Grand Central Palace during the week of Sept. 24, bids fair to eclipse the former gatherings. The initial exposition, held after the first year of the war, was an expression of an industry which was just finding itself in a fairly limitless horizon of possibilities. The sense of the best thought at that meeting was the crying need of an educated, appreciative and just state of mind on the part of the American public. This, happily, is in large manner becoming an established fact.

Chemists, as a whole, were quick to grasp the significance of the exposition idea, and several societies scheduled their regular meetings during the week of the second annual exhibit. The result was large and enthusiastic throngs of technical men in attendance, but with an inevitable duplication of effort and diffusion of attention.

This year the exposition holds the stage alone. Its remarkable growth will be evidenced by the wonderful collection of apparatus, machinery and products of interest to the engineer, and the imposing numbers of models and motion pictures for popular consumption. For such occasions not only furnish a meeting place for technical consultation and discussion of manufacturing difficulties, an assemblage point for the exhibition of the great natural resources of this land of ours which await the transforming touch of modern chemistry, but a place where the man on the street can get an idea of untold possibilities of science and an appreciation of its every-day application in promoting his welfare.

The Nitrate Supply Committee's Recommendations

Nothing is usually more instructive than the problem's formulation. Ten years ago, the question would have been: "Is the manufacture of nitric acid from air practicable?" As it was recently put up to the Government's nitrate supply committee (involving the decision on a $20,000,000 appropriation), the question was: "Which one of at least half a dozen different processes for the fixation of atmospheric nitrogen is the most practical one under present conditions for this country?"

The committee's decision, fully recorded elsewhere in this section, is in favor of synthetic ammonia, followed by oxidation to nitric acid. For the production of synthetic ammonia, the de Jahn process, a new process of the General Chemical Company, differing from the Haber process particularly in the use of a lower atmospheric pressure, is recommended. The decision involves the expenditure of less than $4,000,000, because the

first cost is low, the power requirements being apparently lowest of all processes under consideration, so that no hydroelectric development is to be taken into account.

It should be noted that entirely independently the same conclusion on the relative cost of the different processes is reached in Dr. Maxted's paper, published in our present issue, on the development of the modified Haber process in Great Britain. So far, so good. This independent check of the Nitrate Supply Committee's chief conclusion is exceedingly welcome.

Yet there remains a certain incongruity to be explained, in that an appropriation of $20,000,000 was made and less than $4,000,000 are to be expended. Does this indicate rash extravagance of Congress in making the appropriation and superhumanly virtuous restraint on the part of the committee? Hardly. A much simpler explanation is that those who pushed the $20,000,000 appropriation through Congress thought they could kill two birds with one stone. They figured that in accordance with most prominent European developments the solution of the problem of fixation of atmospheric nitrogen for the needs of this nation would necessarily be bound up with an important waterpower development requiring a large capital investment. This would have furthered two very meritorious objects: First, it would have solved the nitrogen fixation problem; second, it would have helped to relieve, at least somewhat, the present calamitous power situation in this country.

But the Nitrate Supply Committee, which was called upon to make the decision, decided that its only primary object was to select the most suitable nitrogen fixation process, and that the deplorable waterpower muddle was none of its business. As the one nitrogen fixation process most suitable for this country and for the present time, it selected synthesis of ammonia, and was particularly fortunate in discovering a new and highly promising process of American origin. Very probably this was the very best selection that could be made, and the committee and the General Chemical Company, with the chairman of its board, Dr. Wm. H. Nichols, and the inventor of the process, Mr. Frederick de Jahn, all deserve heartiest congratulations.

While the situation thus has its very bright side, don't let us now overlook the dark side. In view of the outcome, it was a mistake in the beginning to mix up the nitrogen fixation and the waterpower problems. The waterpower problem now remains unsolved. Yet, as reflected in numerous important contributions by prominent engineers and business men in the editorial section of this issue, the best interests of the whole nation require that it be solved in the near future.

Problems Before the Chemical and Metallurgical Industries

The universal and insistent demand upon metallurgical and chemical industries, the undercurrent common to all the special articles and interviews in this issue, is for *more production*. Petroleum reserves are steadily diminishing under an enormous consumption. A shortage of twenty-five per cent in the supply of sulphuric acid is imminent. A famine in electrical energy at the very center of electrochemical industry is depriving industrial and militant America of essential substances. The steel works are just drawing a long breath at the end of a panicky bull market, and the copper companies are fighting a multiplicity of strikes, which has made serious inroads into an already deficient output.

Many elements, working together, are necessary for the perfection of a going concern. First, capital. A review of the By-product Coke Oven and the Dyestuff Industry shows how untold millions will be forthcoming from prosperous America to finance permanent industrial expansion. Money may be had in plenty.

Brains are more necessary than dollars. The wonderful evolution of our metallurgical processes in the last forty years is a veritable wonder of the technical world, and a source of inspiration to foreign engineers visiting our country. Chemistry, too long stifled by foreign trade combinations, has leaped to the front from a firm foundation of correct technology. Educators are realizing that real pedagogic problems exist in smoky smelters. Brains may be had in plenty—they will be needed in plenty—and should be mobilized and utilized more wisely by the Government.

Materials are required to build and operate new capacity. Oil drilling is halting for the lack of casings, piping and other essentials. Sulphuric acid cannot be supplied for a lack of pyrite. Metal production waits on a supply of basic refractories and fuel. So far as such shortages are artificially produced by criminal profiteers traitorous to America, they can and are being eliminated by governmental action through big men and patriots. So far as shortage results from a lack of natural resources, the engineer can turn prospector, discovering new sources of supply, or turn experimenter, devising substitutes or developing more efficient utilization of present stocks.

Appears a labor shortage, real and artificial, real in that immigration can no longer furnish the man-power required to match our expanding plant capacity. Artificial labor shortages—strikes—are constantly being accomplished by vicious I. W. W. propaganda or the ubiquitous walking delegate. Real labor shortage can be best combated by the trained engineer—let him devise labor-saving machinery and devices, large and small. Managers should regard it as a patriotic duty to lend every encouragement to such work; they should visit around and see "how the other fellow does it." When our armies are mobilized, short-sighted men will be forced into two alternatives by a hard taskmaster called "war" to improve the process or curtail the output. Artificial labor shortage can best be combated by true Americans, the rank and file of laboring men, in their unions and in the shops. All honor is due to the patriots within the ranks of American labor who have realized their opportunity and are leavening the mass. Their work is pregnant with infinite good.

Any thoughtful engineer cannot fail to see opportunity beckoning him from every side. It is his day! There is a man's work to do! Let's go!

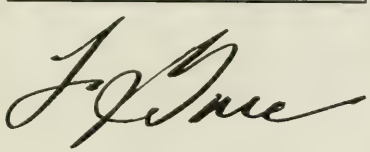
The Niagara Power Situation

By F. J. Tone

Works Manager, The Carborundum Company

One great anomaly in our war activities is that while we have speeded up every other national resource, Niagara remains throttled.

The part set for Niagara industries in the war program is a large one. They must supply the bulk of the ferro-alloys, the all-essential of the steel industry. Ferro-chrome is wanted for armor plate and projectiles. The army must have chlorine for gas shells, camp sanitation, water purification and for the Dakin solution. Explosive makers want caustic soda, potassium chlorate and chlor-benzol. Dirigibles require silicon for generating hydrogen. Destroyers want phosphorus for smoke screens. Abrasives, cyanides, aluminium, electrodes and many other products are urgently needed in the war game. The Aircraft Production Board has decided on the design of the standardized United States aeroplane motor. It will require quantities of ferrochrome for chrome steel crank shafts, chrome steel connecting rods and all parts subjected to the enormous strains of a mechanism weighing less than 2 lb. per horsepower. Quantities of aluminium will go into crankcases and pistons. The modern grinding wheel alone makes possible the finishing to limits of a fraction of a thousandth of an inch all parts of the aeroplane engine and thus the artificial abrasives of Niagara become the key to interchangeability.



To meet this war demand there is actually available 60,000 hp. less than in peace time. In 1916, 175,000 hp. was coming from Canada to the American side. Canada has now cut off half of this and the Ontario Government has authorized the expropriation of all the power which is now being exported to the United States. This complete embargo would cripple the making of war materials here, but the action is held up, it is said, only in consideration of probable reprisal on the part of the United States in shutting off coal going into Canada.

The action of Congress has been wholly inadequate to meet the situation. On June 30 Congress renewed for one year the permit to divert an additional 4400 cu. ft. of water, provided that it was to be used on generators already installed. Inasmuch as sufficient generating capacity is installed to utilize but a portion of this, the additional power is only 35,000 hp.

To help production of war materials the first relief measure should be legislation permitting the installation of emergency apparatus to use the entire amount of water allowed by treaty. Such installation could be made in twelve months. No power company however could undertake to install such apparatus without the assurance that the water could be used for a sufficient period to justify the investment. Therefore as a second relief measure, Congress should legalize the right of the power companies to use water for a fixed term of years. This would enable them to remodel their works so that the water now diverted could be used at the maximum head. The reconstruction work would cover a period of three or four years, but 300,000 hp. would be added to the power supply without diverting any additional water. It would save the nation 3,000,000 tons of coal per annum. A third measure should be the control of erosion at the apex of the Horseshoe Falls. The recession of the crest of the Falls is now 6 ft. per annum and the Horseshoe is rapidly becoming a deep narrow gorge gathering the whole river into a central channel. Invisible current deflectors or submerged weirs placed in the bed of the river above the Falls would deflect the water over the sides of a re-established Horseshoe and would make available double the amount of water now allowed by the treaty with an actual improvement in scenic effect and a saving in the nation's coal consumption of 16,000,000 tons per annum.

Looking to conditions after the war, it requires no prophetic vision to foresee the shifting of our electrochemical supremacy to Canada and Norway. By reason of Niagara power the United States has achieved during the past quarter century a supremacy in electrochemistry such as Germany achieved in the chemistry of dye products and fine chemicals. Remarkable as this development has been, it will no doubt be exceeded in the next quarter century. A score of rare elements and compounds of elements already utilized are waiting to be brought to the service of industry and he would be pessimistic indeed who would say that we will not have other developments rivaling aluminium, calcium carbide, fixed nitrogen and all the products of the electric furnace and the electrolytic cell that have revolutionized our basic industries. These advances will require the power of another Niagara or perhaps several Niagaras, and while we restrict water power development and glory in the amount of coal we burn, Canada is proceeding with a new development below Niagara which will give an additional 600,000 hp. Unless the awakening comes, Canada and Norway will control the electrochemical markets of the world.

Niagara Falls, N. Y.

The American Steel Industry

Kaleidoscopic changes are the normal thing in the American steel industry, hence there is not the least occasion for surprise that the war has effected great changes. The astonishing thing rather is that it required so many months after the war started for the realization to come to the trade that the industry was to be made very prosperous by the war. Many years ago the late James M. Swank, the great statistician of the industry, observed that it always had a chill or a fever. Many years later one of his great admirers coined the saying "prince or pauper," and that has become the common phrase, though as regards conditions existing at the outbreak of the European war Mr. Swank's terminology is by far the more precisely descriptive. The industry was experiencing a severe chill. It was familiar with periods of depression and low prices separating its periods of activity and large earnings, but there had been the unfortunate conjunction, late in 1913, of the period of activity and full production inaugurated in 1913 coming to a close just as a new tariff law was enacted, greatly decreasing the duties. The trade was not in a mental attitude to see that anything good could come from the war.

On the inception of the war a theory was entertained in some quarters that export trade would be stimulated. In terms of finished steel exported directly or consumed in the production of manufacturers, machinery, etc., that were exported, the steel producing countries, Germany, England, the United States, France and Belgium, were exporting to non-producing countries at the rate of somewhat more than 10,000,000 gross tons a year, the exports of the United States comprising less than one-fourth of the total. As supplies from the warring countries would presumably be shut off, here was a chance for heavy exports by the United States. It soon developed, however, that the neutral countries were unable to finance purchases to any great extent, and they were, moreover, in possession of fairly large stocks.

The steel mills operated at about 65 per cent of capacity during the first eight months of 1914, this including the first month of the war, and then their operations decreased rapidly until they were not over 40 per cent in December. Prices dropped to the lowest level since 1898. War steel orders did not begin to appear until about the beginning of 1915, but in the second quarter of the year they multiplied to such an extent as to be considered an important factor. Late in June one of the steel interests announced that it was undertaking a small addition to its capacity, and the incident was hailed as very significant, being the first of the kind for a couple of years. Millions of tons of new capacity have since been added.

The very moderate prices that were asked upon the first inquiries for large steel rounds for making shrapnel shells, 1.10c. to 1.30c., were in striking contrast with prices paid afterwards, in many instances higher than 4c. The inability to recognize at the outset of the war that a heavy demand for steel for war purposes would be created is likewise in contrast with the common appraisal when the prosperity began that it was due directly to orders of war steel. The fact is that the production of steel in 1916, minus all exports, both peace and war material, was materially greater than the domestic consumption in any year prior to the war. This increase was due chiefly to the enormous favorable balance in the foreign trade, produced only in minor degree by the exports of steel and manufactures thereof. The country as a whole was made prosperous, with full employment and plenty of money, hence it naturally consumed steel.

The present rate of production is about 33,000,000 tons a year, or at the rate of perhaps 90 per cent of capacity, operations being interfered with by shortages of labor and transportation. As representative of "steel production" the statistics of the production of ingots are frequently quoted, but they are really merely the record of the ingot scales, a portion of this tonnage going into scrap crop ends which goes back through the steel-making process. The production of rolled steel, the commercial product, is about 76 per cent of the ingot tonnage.

The reversal of feeling on the part of steel buyers, from the attitude of extreme dejection before the war started and the added fear that during the European war normal business conditions could not be expected, was so complete that it quite overshot the mark, and market prices were bid up to levels the producers themselves had never had the courage to expect. This process did not cease until June of this year, when finished steel prices were approximately quadruple the very low prices of December, 1914, and more than triple the average prices for either ten years or fifteen years preceding the war. A readjustment is now being forced, since the price situation was one that could not possibly continue for any length of time.

Conditions since the war started have not, on the whole, been favorable to the making of much technical progress. When it has been desired to increase capacity the new construction was expected to pay for itself, if at all, in a short time, perhaps not much more than a twelvemonth, and relatively little consideration was given to prospective earnings after the war. Hence time was the all-important element in new construction and divergences from accepted practice were not in favor. Despite scarcity of labor and materials many new records for quick construction have been made. As an instance, starting with a foundation previously provided, the Cambria Steel Company built a blast furnace complete in fifty-seven days, blowing it in on July 3, 1917.

The large amount of new construction of by-product coke ovens was not due directly to the fact that Germany was blockaded, causing a heavy demand for coke by-products. There were in operation by-product coking plants that were recovering scarcely any of the valuable by-products, and the first requisite would be to add the necessary departments to these already established plants. The new construction of by-product ovens was due rather to the general prosperity and the

ease with which the construction could be financed. Production of by-product coke in 1913 was 12,714,700 short tons, representing about 90 per cent of the existing capacity. The production in 1916 was 19,069,361 tons, representing the full average capacity for the year. The capacity at present is in the neighborhood of 24,000,000 tons a year, representing about 40 per cent of the country's coke requirements.

One surprise developed in the striving for maximum output at all points was the production of the blast furnaces. Based upon the output in 1912 and 1913, with allowances for the percentage of inactivity and the new furnaces completed in the two years, the available capacity for 1915 was not rated at more than about 35,000,000 tons a year, yet a rate of 38,000,000 tons was reached at the close of 1915, and the old furnaces have since made even a larger tonnage. With about three new furnaces completed in 1915, four in 1916 and nine thus far this year, the commercial capacity is probably somewhat in excess of 42,000,000 tons, but the rate of production is nearly 10 per cent less, chiefly on account of shortage of coke.

The largest annual outputs made by the various countries before the war, in terms of steel ingots and castings, made a total of about 75,500,000 gross tons, divided approximately as follows: Central Powers—Germany, Luxemburg, Austria, and Herzegovina—28.2 per cent; Entente Allies—England, France, Russia, Belgium, Canada and India—27.6 per cent; neutrals—United States, Italy, Sweden, Japan and China—44.2 per cent. Changes during the first year of the war included the transfer of Japan and Italy from the neutrals to the Entente Allies and the occupation by Germany of Belgium together with territory on which was located nearly three-fourths of the French steel-making industry.

In entering the war the United States occupied a peculiar position as to steel. The European countries had diverted nearly their entire steel output to the prosecution of the war, but the output of all belligerents was materially less than the present output of the United States, even though the latter is somewhat restricted as compared with its capacity. Thus the United States can prosecute the war vigorously and still have much steel left.

Germany and Austria have had no occasion to increase their steel output by new construction as they have had capacity in occupied territory to draw upon. France has added but little. England has added, perhaps, 3,000,000 tons to her ingot capacity. The United States, now has an ingot capacity of 50,000,000 tons or more, and is producing at the rate of 45,000,000 tons, against an output in 1913 of 31,300,000 tons from a capacity of 35,000,000 tons or thereabouts. With about 3,000,000 tons of new capacity in the United States in prospect of early completion, the world will have on its hands after the war an annual capacity of about 100,000,000 tons in steel ingots and castings, against a production of 75,500,000 tons before the war. About 18,000,000 tons of this will be in new furnaces in the United States and about 3,000,000 tons in new capacity in England. The balance is largely represented by the amount by which the production of the United States fell below its possibilities. All these figures are necessarily approximations, and no allowance is made for countries other than the United States having operated at less than capacity in former years of peak production.

It becomes clear, however, that the consumption of steel after the war must be approximately one-third greater than it was before the war in order to engage the present plants, and it is equally clear that the United States is much more interested in this fact than is any other country, for it is the United States that will have to find nearly all of the increase in outlet.

It is fortunate that steel is an article that is employed rather than consumed. The demand rests to an extent, of course, upon the general activity of the people, but in much larger degree it rests upon the inclination of capital to seek employment in undertakings which in the main have an element of risk in them. It is for this reason that the demand for steel, particularly in the United States, fluctuates so widely. The annual "consumption," or more properly speaking "absorption," has reached as much as 600 pounds per capita. Nowhere else has the proportion been anything like so large.

The war is being waged to make the world safe for democracy. It will then also be safe for capital. Such was not the case before the war. For years previous, every time there was a depression in the world's business one of the causes assigned was the fear of Europe becoming embroiled in a war. Even with no distinct prospect of war there were many regions in which it was altogether unsafe to invest capital even though the promised returns, safety being granted, were very large.

One can rest assured that after the war, in the new and better world it thrills us to think we are making sacrifices to create, there will be almost unbounded opportunity to employ steel in new ways. In addition to this there will be much steel required for reconstruction. It is a question of whether capital can be found for the work, but in the last analysis what is commonly known as "capital" is not a fixed thing. It is largely the creation of confidence, and confidence begets credit, which is closely akin to capital. In the new order of things everyone will work and will work hard. The world will have learned more of how to do things and do them quick, for the war has taught much with respect to construction work.

The United States can do either of two things. It can isolate itself with a tariff wall as it did after the Civil War, or it can employ scientific tariffs designed to encourage imports of things we need and encourage exports of things we can spare. Adopting the latter alternative it must undertake to finance, even in some cases to operate, many of the projects upon which it must depend for an outlet for a part of its increased steel production. The domestic consumption may also be expected to be materially larger than at any time previous to the war.

Petroleum

In an interview with Mr. A. C. Bedford, President of the Standard Oil Company of New Jersey, on September 12, Mr. Bedford said:

Before the war the demand for petroleum products was rapidly growing. It led to the prediction that the era of coal was giving way to the era of oil. Inventive and scientific genius had discovered many uses for crude oil derivatives with the result that the world was beginning to realize the economic value and diverse uses of petroleum.

Take gasoline, for example. It long had been a product which was regarded as of little value. Then came the invention of the internal combustion engines and its adaptation to the automobile. How the automobile has increasingly called for gasoline is shown by the fact that in 1899 there were 10,000 cars and in 1905, 85,000 cars. Then the numbers jumped rapidly, as, for instance, from 1,253,875 cars in 1914 to approximately 3,500,000 on the first of July of this year. The production of gasoline likewise jumped from over 6,000,000 barrels in 1899 to about 45,000,000 barrels in 1916. Thus the invention of the internal combustion engine greatly changed the problems of oil refining, for gasoline has now become one of the most desirable of crude oil products.

With this increasing demand for gasoline and other products, there developed an increasing call for crude oil for refining purposes. The total consumption of crude oil in 1904 was 117,000,000 barrels and it rose steadily to 324,375,503 barrels in 1916. Up until a few years ago, however, consumption by no means followed closely on the heels of the total production. Here are figures that show how the demand for crude oil has become greater than the available supply in this country:

Total U. S. Crude Production	Total Consumption of U. S. Crude
1914....301,527,000 bbls.	1914....265,762,535 bbls.
1915....302,989,533 bbls.	1915....281,104,104 bbls.
1916....308,272,519 bbls.	1916....324,375,503 bbls.

These figures represent "marketed production," *i.e.*, the amount of crude recorded as passing through the pipe lines last year (300,767,158 barrels), *plus* the amount withdrawn from storage, *i.e.*, from supplies previously stored in the field (23,608,345). In addition to these figures, almost 23,000,000 barrels of Mexican crude were imported and consumed in 1916, and over 16,000,000 barrels in the first six months of this year. There are not available to-day tank steamers enough to bring any material increase in these importations.

The latest figures taken from published sources of information for 1916 production, 308,272,519 barrels, prove somewhat better than the earlier estimates, and during the present year, from figures available for the first six months, the U. S. production of crude was on the basis of about 312,000,000 barrels annually.

But the consumption has been going on at the rate of approximately 330,000,000 barrels for the year. The supplies of crude oil in field storage and with the pipe line companies has consequently continued to decrease in spite of new production (of which more will be said later). The amount of petroleum stocks in storage has decreased from 174,370,500 barrels on January 1, to 164,590,942 barrels on July 1, a reduction of 9,779,558 barrels. This reduction, however, is largely in the crude stocks in California.

The war has added still further to this demand for oil production, coming as it did on top of the normal development of the automobile, the aeroplane, the naphtha launch, the farm engines, and the fuel-oil burning ships which already were making a big call upon the supply.

The necessity for oil supplies for the prosecution of the war has been a heavy drain upon the United States. This is due to the fact that the revolution in Mexico prevented the proper development of those fields. Then came the destruction of the Roumanian oil fields. The Allies have been calling for more and more oil products every year.

The export of gasoline in 1914 was $4,193,853 barrels, which increased to 5,632,182 in 1915, and then to 7,120,000 last year. Now comes the United States government with increased demands for gasoline for submarine chasers, aeroplanes, trucks and tractors, and many other purposes. It is estimated that the demands for the present year for gasoline will amount to more than 50,000,000 barrels.

Refiners, with their capacity enlarged until to-day they are handling about 330,000,000 barrels of crude oil in the course of a year, have done much to meet this situation. They have employed the best scientists and the best experts, who have developed means of extracting more than the ordinary amount of gasoline from crude oil by the invention of methods for cracking the heavy oil and refining it into gasoline. Herein the refiners have proved of immense value to the country and to the Allies in prosecuting the war, because they have at the expenditure of much capital provided the means for turning out the needed gasoline.

Had it not been for the introduction of the cracking process, the supplies of gasoline would long ago have fallen short of the amounts that actually have been required and used.

Another way of increasing the supply of gasoline is by the extraction of it from casinghead gas and natural gas. This industry is being developed and this year approximately two and a half million barrels of gasoline will probably be produced from this source. It is likely that more will be produced next year.

The demand for gasoline next year probably will exceed 55,000,000 barrels. That means it is necessary to produce still more crude oil; and here is the grave situation.

Despite the fact that the prices of crude oil have almost been record-breaking, and, therefore, offered good inducements to the prospectors and owners of wells to drill wells and turn out as much oil as possible, the figures for the first half of 1917 show that the number of wells drilled were 10,564 with an initial production of 692,718 barrels. In the first half of 1916,

12,658 wells were developed with an initial production of 800,266 barrels.

Thus, even with what seemed to be alluring prices for crude oil, the new production this year was less than the corresponding period last year. There are several reasons for this. First, there has been an increasing scarcity of casing and drilling materials caused by the demands upon the steel and iron mills for war production and their inability to supply the oil well drillers. The price of tank steel has almost been prohibitive. Next, the price of labor in the oil fields has also greatly increased. There has not been the profit to the oil producers that the public has ordinarily supposed, because the high price of materials and labor has added tremendously to the producing cost.

A general survey of the situation leads to the conviction that in order to produce the amount of crude oil needed, it is necessary to encourage more drilling and to find new fields of oil. To do this, it is necessary to pay prices for crude oil that will provide a reasonable profit to offset the high prices now paid for labor and for drilling materials. It is necessary also to make arrangements so that there will be a supply of pipe and casing. If this is done, the oil situation will speedily adjust itself. The supplies of petroleum which old Mother Earth still holds hidden are almost incalculable, but they are there to be drawn on if the proper effort is made. And with the capacity of refineries already enlarged to meet the increased requirements, and improved methods of refining to insure the maximum extraction of gasoline from the crude, all that is needed is—to get out the crude.

The Nitrate Supply Committee's Final Recommendations

The fixation of atmospheric nitrogen for the purpose of national defense has been the subject of extended and extensive official investigations during the past year. Section 124 ("nitrate supply") of the National Defense Act of Congress of June 3, 1916, authorized an investigation into the best, cheapest and most available means for the production of nitrates by water power or any other power that may be best and cheapest. To permit rapid action in backing up the conclusions reached in this investigation, Congress appropriated $20,000,000. The scientific investigation was in the hands of technical committees appointed for this purpose; the collection of all possible further information was in the hands of the special agents.

One of these agents was Mr. Eysten Berg, who visited Europe and submitted a report. Another of these agents was Dr. Charles L. Parsons, Chief Chemist of the Bureau of Mines, Interior Department, who, in the course of his investigations, visited the noted plants of Italy, France, England, Norway, and Sweden during the fall of 1916, and was able to give in his reports a most valuable summary and comparison of recent progress and conditions in the nitrogen-fixation industry at home and abroad, elaborated by extensive statistics of a confidential nature.

The first committee of scientists and engineers was appointed at the request of the Secretary of War by the president of the National Academy of Sciences in co-operation with the American Chemical Society, and consisted of Arthur A. Noyes, chairman; L. H. Baekeland, Gano Dunn, Chas. H. Herty, W. K. Lewis, M. I. Pupin, Theo. W. Richards, Elihu Thompson and W. R. Whitney.

This committee was succeeded and its work continued by a new committee—the "Nitrate Supply Committee"—appointed by the Secretary of War, and constituted as follows: Chief of Ordnance William Crozier, U. S. A.; Chief of Ordnance Ralph Earle, U. S. N.; Chief of Engineers Wm. M. Black, U. S. A.; F. W. Brown, L. H. Baekeland, Gano Dunn, Chas. H. Herty, Wm. F. Hillebrand, Arthur A. Noyes, Chas. L. Parsons and W. R. Whitney.

Of the progress of the investigation very little was heard during the past year, until it became known some weeks ago that the final decision reached was to put to immediate use less than $4,000,000 out of the total of the $20,000,000 "nitrate supply appropriation" of Congress until further information was given out by the Secretary of War at the end of last month. He first gave the details of the conditions as to the work to be undertaken at once by the Government, and second, published several reports in abstract written by Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, as special agent.

The principal feature of the final recommendations of the committee, as indicated by this statement, is the manifest conviction that under the conditions now existing in this country those nitrogen fixation processes are most suitable which require the least amount of power. For this reason the committee does not favor those processes which have assumed greatest commercial importance in Europe in connection with immense hydro-electric developments. This explains at once why less than one-fifth of the total $20,000,000 appropriation of Congress is to be used up—there will be no large expensive water-power developments.

> The final recommendations of the Nitrate Supply Committee are as follows: that out of the total available nitrate supply appropriation of $20,000,000 a sum of $3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the process of the General Chemical Company, and of a capacity of 60,000 pounds of ammonia per 24-hour day, the plant to be located in a region where land, water, coal, and sulfuric acid are cheaply available, where good transportation facilities exist, and where the proposed new powder plant of the Government can be properly located. In the opinion of this committee all of these conditions just enumerated are best fulfilled by a location in a southwest Virginia or contiguous region.
>
> That out of the $20,000,000 appropriation a further amount of $600,000 be placed at the disposal of the War Department to be used in building a plant for the oxidation of ammonia to nitric acid and the concentration of nitric acid, of a capacity equivalent to 24,000 pounds of 100 per cent nitric acid in a 24-hour day, the plant to be located in the neighborhood of the synthetic ammonia plant and the proposed new powder plant of the Government.

That experimentation looking toward the industrial development of the Bucher process for the production of ammonia be at once proceeded with, and further that, contingent upon a satisfactory arrangement with the Nitrogen Products Company, a sum not to exceed $200,000 be allotted for this purpose out of the $20,000,000 nitrate supply appropriation.

That out of the $20,000,000 nitrate supply appropriation, $100,000 be made available for the active prosecution of investigations of processes for the industrial production of nitrogen compounds useful in the manufacture of explosives or fertilizers, and that these investigations be planned and supervised by the War Department.

That, in order to increase the production of ammonia and toluol, the Government promote the installation of by-product coke ovens by directing that priority be given in the production, delivery and transportation of the materials and parts needed in their construction.

That the decision as to more extensive installation of nitrogen fixation processes and water power development in connection with them, be postponed until the plants above recommended are in operation or until further need arises.

That the immediate accumulation and permanent maintenance of an ample reserve of Chile saltpeter not less than 500,000 tons is most urgently needed in this country.

The foregoing report having met with general approval, the Secretary of War directed the Chief of Ordnance of the Army to proceed to carry out the committee recommendations on the synthetic ammonia and nitric acid plants, and announced that for the present the consideration of development of large water-power installations which had been begun by the Inter-departmental Board (Secretaries Baker, Lane and Houston) appointed by the President would be suspended.

Pending actual developments, the Ordnance Department of the Army is proceeding as energetically as possible with the work intrusted to it, has made arrangements for taking over orders at cost which the General Chemical Company had placed for the necessary apparatus for the construction of a considerable plant for their own use, and thus gains considerable headway upon much of the apparatus as well as favorable prices. The J. G. White Engineering Corporation has been engaged for the remaining engineering work and the actual construction; the plans for apparatus are essentially complete, and designs for all of the buildings are very nearly completed as a result of work done by the engineers of the General Chemical Company.

One of the reports, dated Jan. 27, 1917, which Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, prepared for General Crozier, gives interesting data on the arc process, the Haber process, the Cyanamide process, and by-product coke-oven ammonia.

Concerning the *arc process*, which is operated on a very large scale in Norway, it is said that in spite of the very low efficiency of the process, yet on account of the very cheap horsepower available in Norway and the fact that the raw materials cost nothing and are always at hand, nitric acid can there be produced by the arc process at a cost less than by any other commercial process.

The cost of horse power used for the production of nitric acid in Norway is less than $5 per horse-power year. The best estimates in my possession indicate that with horse power at $10 per horse-power year, the cost of finished strong nitric acid at the plant would be as cheap as by any other process now in operation. However, the low cost of producing nitric acid by the arc process is outweighed by so many other disadvantages that, in my opinion, the process is entirely inapplicable to the uses of the United States Government, and this opinion appears to be shared by all who have given careful thought to the subject. The cost of installing the arc process is high and it involves the use of an amount of horse power that seemingly is not available on the American continent within reach of the points where the nitric acid would have to be used.

Nitric acid is not economically transportable. As strong nitric acid it can be transported only if tank cars made of aluminium can be obtained, and aluminium is a metal that, for this purpose, has many disadvantages besides cost. The nitric acid might be transported mixed with sulfuric acid in iron tank cars, but this involves the erection of large sulfuric acid factories near to the nitric acid plant and a large addition in freight rates. Freight rates on such nitric acid as is transported are very high and must always remain high on account of the dangers involved.

The great difficulty that has faced the Norwegian plants from the beginning, namely, a market for their products, would in peace times be a serious obstacle to the operation of a large arc plant in the United States. An arc plant at its best involves the use of 2.33 horsepower years per ton of weak nitric acid. This means that a water power development of at least 50,000 horse power would be necessary for the peace requirements of the Government, and a development of 440,000 horse power would be required for war purposes. These figures are minimum figures on the basis of the relatively high efficiency reached in Norway. No installation should be considered by the Government of less than 75,000 horse power for peace requirements or 550,000 horse power for war requirements. If the arc process is to be used it would also be advisable to arrange for the production of explosives at the point where the arc plant was located. This would of course involve the transportation of all other raw materials needed, such as benzol, toluol, alcohol, acetone, glycerine, sulphuric acid, cotton, and other materials too numerous to mention, to the plant and the transportation of the finished explosives therefrom to the place of consumption. As these materials are highly combustible and for the most part carry high freight rates, it has been found necessary the world over to locate the plants intended for the production of munitions near to the point where the munitions are likely to be consumed.

Among the recommendations of this report is one for the reservation of a supply of platinum.

As platinum is an essential for the oxidation of ammonia and of the utmost importance in the production of sulfuric acid and other supplies required for munitions; as there are no platinum reserves in the United States save a small amount obtained in the electrolytic purification of copper, gold, and silver ores; and as platinum is one of the precious metals with a value above that of gold, I especially recommend that legislation be asked which will conserve the platinum obtained each year by the United States mints, putting it in the vaults if necessary and issuing treasury notes against it as in the case of gold. Platinum would then be available for immediate use in case of need for the

production of nitric acid by the oxidation of ammonia and for the production of sulfuric acid so important in case of war. This platinum would be available without cost to the government and could, if desired, be used as a reserve for circulation, because even if applied to the purposes above mentioned there would be comparatively little actual loss of the metal itself.

The construction of a hydroelectric plant is recommended only if the arc or cyanamid process is used.

I seriously doubt whether hydroelectric power will be necessary or desirable three years from now for the most efficient process of fixing nitrogen, and accordingly I deem it unwise to install such hydroelectric power at great cost with the sole purpose of producing nitrogen. If, however, such water power can be utilized by the Government in the production of certain ferro alloys absolutely essential for ordnance and other munitions; can be sold to commercial companies who will take upon themselves the financial risk involved in the erection of plants for nitrogen fixation, under guarantee of cheap ammonia to the Government; or can be sold during peace times to companies requiring power for purposes which would allow instant requisition of the power by the Government in time of war without handicapping the supplies of other needed war material, the development of such hydroelectric power would be highly desirable.

A second report by Dr. Charles L. Parsons (April 30, 1917) is particularly interesting, for the data it gives on the new synthetic ammonia process of the General Chemical Company.

The General Chemical Company, through the chairman of its board of directors, Dr. Wm. H. Nichols, has offered to the Government the use of the de Jahn process free from any charge or royalty for the purpose of explosive manufacture, while for fertilizer manufacture a royalty of $5 per ton of 2000 lb. of fixed nitrogen in any form shall be charged. (This represents a charge of not more than 25 cents per ton for the usual mixed fertilizer.)

The de Jahn process has been developed in the past four years by the General Chemical Company for the synthetic production of ammonia by direct combination of hydrogen and nitrogen. Lower pressures are used in it than in the Haber process. It has been in successful operation on a large experimental scale with several small units for ammonia production, and with one unit larger than those supposed to be used in Germany with the Haber process. It is considered to be the least expensive and most easily installed of all processes investigated by the committee.

The General Chemical Company has also developed and brought to a commercial basis the production of a mixture of nitrogen and hydrogen from coke, air, and water, which will yield hydrogen at a cost lower than heretofore obtained in this country and probably lower than that obtained in Germany.

As to cost of construction and operation it is estimated that even under present conditions a 30-ton per day plant can be built for an expenditure of $3,000,000 and can be operated at a cost of not to exceed 4 cents per pound of ammonia produced, allowing $5 per ton of product for repairs and 12½ per cent of the cost of the plant for interest and depreciation. It is believed that the charges for repairs, interest and depreciation are excessive, as, together, they comprise more than 50 per cent of the total cost of the ammonia production. In the estimate $3 per ton of product is allowed for general expenses and overhead charges.

It is estimated that a smaller plant of at least 7½ tons per day capacity can be built at the present time for approximately $1,100,000, including land and buildings. Such a plant would yield 2700 tons of ammonia per year—equivalent to 8700 tons of 96 per cent nitric acid, assuming 85 per cent recovery.

The following table gives comparative construction and operating costs of the various comparative processes:

	Arc	Cyanamid	Haber	General Chem.[1]
Product	35% HNO_3	NH_3	NH_3	NH_3
Power required	10.5	2.2	0.2	0.2
Investment	$1,410 (a)	$440 (a)	$340	$300
Operating costs[2]	170	150 (b)	119	97
Product	96% HNO_3	96% HNO_3	96% HNO_3	96% HNO_3
Power	10.8	2.3	0.3	0.3
Investment[3]	$1,570	$670	$770	$720
Operating costs[4]	220	270	239	217

With respect to the Bucher process, Dr. Parsons mentioned that this new process has been developed by Prof. J. E. Bucher (described in this journal, Vol. XVI, page 315, March 15, 1917). The fundamental idea is to produce ammonia through cyanide as an intermediate product. The process is owned by the Nitrogen Products Company, and is used on an experimental scale in two plants at Saltville, Va., in a coal-fired furnace, and at Niagara Falls, N. Y., in an electric furnace. The president of the Nitrogen Products Company, Mr. Edward E. Arnold, who six months ago declined to go on record as to the future of the process, now unequivocally states that he considers the process a certain commercial success and a probable competitor with any other process for the production of fixed nitrogen. This company has offered to the Government the use of the Bucher process under conditions like those tendered by the General Chemical Company.

For the change of the ammonia into nitric acid two types of processes are available: the Frank Caro process and the Ostwald-Barton process. A third promising possibility is the oxidation of ammonia or cyanamid direct to ammonium nitrate in solution.

The present commercial efficiency and output by the Ostwald-Barton process is higher than by any other concerning which exact figures have been obtained. It is higher than the published figures for the Frank Caro process, but as figures for that process have been published only on a minimum basis, it is impossible to state whether a high efficiency of conversion and capacity of catalyzer has been reached by that process.

[1] Estimates on General Chemical Company process are based on present wartime construction costs. All other on normal prices.

[2] Amortization for cyanamid as charged by operating companies. Amortization for Haber 20 per cent of plant cost for repairs, interest, depreciation. Amortization for Arc and Modified Haber 12½ per cent interest and depreciation. $5 per ton of product for repairs.

[3] Except for Arc process, includes ammonia plant as given A, power additional, $10; oxidation and absorption, $140; concentration, $40; steam plant, $40.

[4] Except for Arc process, includes ammonia costs as given; oxidation, $50; concentration, $70. No allowance made for unoxidized ammonia.

(a) Power plant investment reckoned at $100 per horsepower.

(b) Cyanamid production, $122; ammonia from cyanamid, $28; total, $150.

The Colleges and Their Neighbor's Smoke

By Herman Schneider
Dean, College of Engineering, University of Cincinnati.

Davy Crockett was a great man, and he lived at the right time. He was a mighty individualist, and individualists were needed in his day. His favorite expression was said to be, "I'll move on as soon as I can see my neighbor's smoke!" And he did. By moving on, he and kindred spirits made it safe for us to settle down.

For settled down we are, with our neighbor's smoke all about us, and individualism a thing of vacation time only. We work together, talk together, progress together, or get out of the procession entirely. Even those super-individualists, the I. W. W., flock together.

Herman Schneider.

The great man of this day is the one who can attune his powerful individuality to the hazily forming ideas and ideals of a hundred million individuals; the one who can think nationally, feel nationally, and act nationally; whose neighbor's smoke speaks of mutual interdependence and stirs the imagination to the nation-wide to-morrow of all of us, rather than to the arm's-length to-day of himself. Whether your work is in iron or ice or putty or prunes or eatables or education, the statement holds. It sounds oratorical, perhaps, but all big things sound oratorical on the first statement.

Living to-day is like reading an old-time thriller. You never know what is going to happen on the next page; generally it is the unexpected that does happen. Prophecy is permissible and pardonable only as a form of individualistic blow-off—heredity must be heard—but the safe working basis is to assume the big fact that hereafter we, the people of the United States, will work together like a Roman phalanx. There is no *or, but,* or *if* to this. It is in the minds of the people, and that settles it.

Just what form of phalanx we shall evolve no one can tell. But we do know that the plan will shape itself around the idea that in this land all things must *work together* for good—the good of all of us. If that sounds too altruistic to you, if your individualistic tendencies buck at it, there is just one thing for you to do—get used to it. If you don't get used to it, if it doesn't become actually a part of your working organism, the phalanx will simply walk by you, perhaps over you.

In every line of activity the potential men who sense this notion to think nationally and to act nationally, will some day be the leaders in that activity. They will reach out to any smoke that has to do with their work, and coordinate all the fires into one intelligently working organism.

College professors love the word *autonomy.* Any daredevil who tries to monkey in a faculty meeting with the autonomy of the college departments is guilty of treasonable practices. So far as the colleges are concerned, the first difficult task to meet the changing order will be the coordination of all the departments into a closely knit organization. Following that, or while it is under way, will come the great revolution: bringing the colleges actually, not on paper, into the mills, the government, the farms, the railroads, and more especially into the very difficult problems to be faced in all of these human affairs. For in the new plan of having all things and all persons working together for good, the colleges will have a mighty task to perform.

It will be their job to train nationally; their training ground will be where things are done, and their equipment all that has educational value. The scientific problems will be many and difficult; but the problems of human relations will be more and doubly difficult.

To meet these in the new order, men must be trained at those places where *the problems actually exist,* and not where they have merely an academic interest.

This is the educational trend.

Davy Crockett is still paramount in some of our colleges, but you will see the day when the professor and his students and the producer and his fellow-workers will wonder how they got along without each other in their daily tasks. For we are at the dawning of a real democracy in which we shall think nationally, feel nationally and act nationally.

Cincinnati, Ohio.

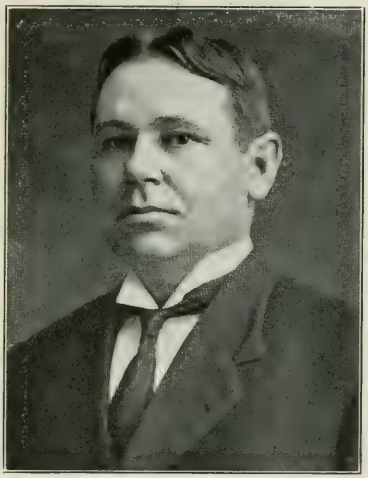
The Sulphuric Acid Situation

By Henry Howard

Chairman of the Executive Committee, Manufacturing Chemists Association of the United States.

There is probably no single article that is of more vital importance to the successful conduct of the war than sulphuric acid; without it, the manufacture of high explosives is impossible; without it the intensive production of food through the use of fertilizers also becomes impossible; large quantities are absorbed in the refining of petroleum, with the consequent production of gasoline and lubricating oils; and finally, it enters into the production processes of most chemicals whose applications in the arts and sciences are almost without limit.

Up to the beginning of the war, the sulphuric acid industry had had a steady and normal growth for many years, and the plant capacity was substantially in excess of the requirements of the country. The result was, that just before the declaration of war, many plants were not operating at anywhere near their full capacity. By April, 1915, this surplus capacity had practically all been absorbed, and three or four months later an acute shortage occurred which resulted in the construction of a large number of new plants.



Henry Howard

The production of sulphuric acid is, of course, largely dependent upon the supply of the raw material, namely, pyrites or sulphur. A discussion of the sulphuric acid situation involves a consideration of our available supplies of these materials as much as of the available capacity.

Up to the beginning of the war, nearly all the sulphuric acid made in this country was made either from pyrites or from the gas recovered from smelting sulphide ores, the sulphur from Louisiana and Texas being almost exclusively absorbed in the paper mills for the manufacture of sulphite pulp. Nearly all the acid made from pyrites within a reasonable distance of the Atlantic seaboard was made from imported pyrites, principally of Spanish origin, so that any interruption in ocean traffic would be likely to cause serious embarrassment to the acid manufacturers of the Eastern United States.

Up to January, 1917, there was no great difficulty in obtaining all the Spanish pyrites required, but almost immediately after the opening of the unrestricted submarine campaign, it became exceedingly difficult, if not impossible, to ship Spanish pyrites to this country. These conditions would have brought about a desperate situation in this country had it not been for the Louisiana Sulphur Company and the Freeport Sulphur Company. These companies, at the request of the Chemical Committee of the Council for National Defense and acting in a most patriotic manner, have come to the rescue of the acid manufacturers by supplying huge quantities of sulphur at prices only slightly above the normal pre-war prices for sulphur. It must be remembered, however, that these prices, low as they are for pure sulphur at the present time, are nearly double what the acid maker was formerly paying for his sulphur in the form of pyrites. The production of sulphur from the wells of the Gulf States is, however, not capable of immediate or indefinite expansion, for it requires huge installations of high pressure steam boiler capacity. It is therefore impossible to expect a prompt and unlimited quantity of brimstone from these regions.

In the meantime, the Chemical Committee of the Council for National Defense, through Mr. A. D. Ledoux, chairman of the Committee on Pyrites, has been carrying on negotiations with the English Government regarding the resumption of shipments of Spanish pyrites. These negotiations are now bearing fruit and substantial tonnages have been coming forward during the months of July and August with a number of vessels already chartered for shipments to be made in September. The Institute of Mining Engineers is actively engaged in the exploration of domestic pyrite mines, and some increase in supply from this source may be expected.

In general, it looks as if the existing sulphuric acid plants would be able to get the amount of sulphur and pyrites necessary to maintain continuous operation for the next six months or more, but at greatly increased prices. On the other hand, it would appear that the production of sulphuric acid will be inadequate to meet the demand during the balance of the war owing to the tremendous increase required for the production of fertilizers and explosives. Consequently, before next spring it will probably be necessary to arrange for the establishment of a preference committee to decide how the acid shall be distributed.

It has been estimated in Washington that the production of all grades of sulphuric acid, calculated as 50 deg. Bé., was 6,250,000 tons in 1916, and that requirements will be 8,000,000 tons in 1917.

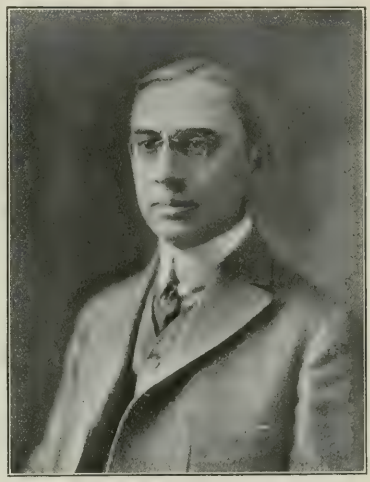
Predictions of any sort, however, are very dangerous to make in these days because of complex conditions. For instance, if the transportation systems are deranged by pressing war demands, deliveries of phosphate rock will slow down. The increased demand of the fertilizer manufacturers for sulphuric acid then will not materialize.

The American Dyestuff Industry

By I. F. Stone

Vice-Pres., National Aniline & Chemical Co., Inc.

On the outbreak of the war there were but five American color producers, limited to the manufacture of the so-called "original" colors, direct dyeing cotton colors, and acid and chrome colors for wool and silk which they were able to manufacture successfully in competition with Europe. The chemical industry was then making full use of all the opportunities presented to it under normal conditions. They could not compete with the German manufacturers, first, because of the great advantage in capital, experience and everything that goes with a successful and enormous business; second, because it actually costs 44 per cent less in Germany to make colors than it does in the United States; and third, the domestic manufacturers are prohibited by law from making use of co-operative commercial devices such as pools, trusts, manufacturing and selling agreements such as are wholly lawful abroad and encouraged by their governments.



It may be interesting to briefly sketch a history of this industry from its first inception in this country. The first American aniline factories were established about 1875. By 1880 there were some ten factories engaged in the manufacture of these products, and it looked as though it would be a very successful industry. Unfortunately, however, in 1883 a new tariff law was passed, reducing the protection on colors to such an extent that the industry was no longer possible, and consequently most of the factories dropped out until there were only three engaged, carried on more or less by the ambition of their owners rather than at a profit. About 1898 another factory was established, and along about 1914 still another. Owing to the intense competition of the European manufacturers, especially the Germans, none of these factories were successful enough to make a complete line of colors, and were restricted to only a few which could be made to advantage in this country. Again, they were forced to rely entirely upon European manufacturers for their raw materials; in other words, the intermediates, and naturally the European manufacturers charged them such a price that they could not successfully compete with the finished colors of Europe, made from the same intermediate products purchased at a lower figure.

In 1914, therefore, the American firms were making hardly one-tenth of the domestic consumption, and that largely with imported intermediates. At the beginning of the war, it was of course impossible for the German factories to ship their usual quantities because of the fact that the government had taken charge of all means of transportation for troop movements. After a couple of month's interruption, however, comparatively regular foreign color shipments of about 75 per cent of the normal sales arrived until the spring of 1915, when they ceased entirely. This was, I believe, partly due to the action of England taking measures to prevent such shipments, and partly because the Germans were disinclined to sell when they could not get needed supplies like cotton and foodstuffs in return. In the face of this famine, most consumers were forced into part-time operation at great loss to themselves and their employees, or into lines which required little or no dyestuffs or such colors of American manufacture as could be had. In some lines, for instance, the hosiery and possibly the leather manufacturers, this can be done to quite a large extent, as they mostly use blacks and other dark colors which were manufactured comparatively largely here; that is, for hosiery, direct and sulphur blacks, and for leather, blacks, nigrosines and logwoods. These were made and could be obtained in the United States almost in the necessary quantities.

Unfortunately for the aniline makers, however, at the outbreak of hostilities an embargo was immediately placed upon intermediates, for reasons best known to the German government. These essential substances could not be previously produced profitably in America. Had it not been for a small and precarious local production of aniline oil and nitrobenzole, the American dye works would not have been able to continue. They immediately began making intermediates, as under those abnormal conditions it was not a question of price, but of ability to manufacture aniline dyes almost no matter at what cost, such was the demand. After some months a number of new concerns also started in business, chiefly making easily manufactured intermediates; before that time the established aniline works had expanded their regular products to such an extent that by the beginning of 1916 they were making about four times their former production of finished dyes.

As an illustration of the importance of the dyestuff industry in its relation to other American industries, it may be stated that the textile manufacturers, comprising their cotton, wool, carpet, knit goods, silk, cordage, shoddy dyeing and finishing branches, absolutely require a great quantity of dyes in their operations. Add to this the leather manufacturers and tanners, the paper manufacturers, the paint and color manufacturers, printing establishments, ink makers, shoe dressing man-

ufacturers and a hundred and one other lines which consume dyestuffs, and I think I could safely say there are upward of two million employees who are affected by any shortage in dyestuffs.

At the present time there are over 100 firms directly engaged in the manufacture of crudes, intermediates and colors, with a combined investment estimated at $50,000,000, producing a quantity of finished dyes greatly exceeding in quantity the entire consumption during 1914. The American works, led by the old established factories, are now producing practically a full line of basic, acid, chrome and sulfur colors, and in the future will be able to produce enough to take care of the demand, if the consumers are careful enough to make forward contracts so that the factories can be prepared with the necessary installations and raw materials. They are willing to increase their facilities to practically any extent as long as customers will support them by making contracts. As to future expansion, there is no reason why any properly equipped chemical manufacturing company in the United States cannot supply the same quality and amount of colors as we were getting from Germany. We have the raw materials, we have the ability and the skilled labor.

Fortunately, Americans have become alive to the advantages of the by-product coke oven, and the construction of such ovens has recently gone on apace, and the local production of raw materials is now ample for all the demands of the dyestuff industry. For instance, we are already independent of Europe in benzol, which will always find a ready market for its surplus as a motor fuel. Ample benzol has made it possible to manufacture phenol (carbolic acid) synthetically, which latter substance is produced in less proportion to the consumption than any of the chemicals occuring naturally in coal tar. Toluol is of more importance than benzol to the nation on account of its use in the explosive field rather than for its use in the manufacture of dyestuffs, and an increase in supplies in benzol brings increased supplies of toluol. More naphthalene and anthracene is being recovered and refined from the heavier portions of the distillate by a revision of the specifications for creosote oil, and no doubt more of these substances can be recovered by the by-product plants if the proper demand is assured at a price commensurate with the added investment and cost of manufacture.

German chemists probably have $400,000,000 invested in the dye industry. They do not intend, if they can prevent it, that the color industry get a sound footing in the United States. I believe they will resort to the extreme of price-cutting and unfair methods to kill off any competition with their own export trade. In order that we may understand and properly provide for this contingency the following should be considered:

The materials of the dyestuff industry are used in the coal-tar explosives industry as well as for coal-tar medicinals. Each of these three industries co-operate with the others to make full use of these materials; alone none can fully make use thereof nor succeed; the correct and proper utilization of these materials requires successful co-existence of all three industries in one and the same country.

It is further clear that the stability of a complete domestic chemical industry, in so far as it depends upon commerce, is bound up to a successful merchant marine and to an efficient foreign banking condition.

The color industry will require a plentiful supply of all chemicals, including the so-called heavy chemicals, all of which will, doubtless, be obtained from American sources.

It will also require quantities of all basic raw materials and intermediates derived from coal tar in practically chemical pure form. The war has greatly stimulated the manufacture of a number of these products, unfortunately mostly for use in explosives.

The manufacturers of intermediates and colors during the abnormal war conditions have been able to obtain an abnormal profit out of which they have built and paid for their factories. They are now therefore in the same financial position as the German factories.

The United States Government has finally discovered that in order to make this industry permanent it is necessary to give more adequate tariff protection, and a tariff bill passed in 1916 giving this additional protection allows the American manufacturers a very much better opportunity.

The American consumers have realized the importance of having an aniline industry in this country, and therefore they will undoubtedly give the preference to American-made products.

A first step toward the mobilization of all the factors of this situation has been taken by the amalgamation of several old-established concerns into one large company which will now be in a position to centralize productive effort and capital in all the steps from the mining of the coal, through the by-product plants, intermediate and chemical manufacturing, to color making, selling, and research.

To sum up briefly the whole question of the permanency of the American dyestuff industry, it is apparent from the above that with united factories capable of producing the necessary colors, an adequate tariff, a strong financial condition established during the war, and the preference of American consumers for American products, we have certainly insured the permanence of the American dyestuff industry.

The high prices charged by American manufacturers of colors are due to, first, the demands of the explosives industry, which uses the same raw materials, and second, the high rates of wages paid by the industry. Products will revert toward their normal levels when these other matters reach normal conditions. It is very difficult to say whether labor charges will ever revert to their pre-war basis, as the laboring people have been educated to a higher schedule of living, and it is doubtful if conditions will change much in this respect. I believe, however, that American consumers will be only too glad to pay labor everything it is worth, and consequently a higher price for colors than ruled before the war will be cheerfully paid by our consumers, if they are within reason, which they will be.

New York City

Electric Furnaces

By Francis A. J. FitzGerald,
Consulting Engineer
Fast-President, American Electrochemical Society

Although electrometallurgical furnace plants were increasing before the Great War the increase was not as rapid as it should have been. The increased production of electric steel showed that this development was slowly approaching the point it should have reached, but it was still relatively if not absolutely below the European level. The United States Steel Corporation had built a large Héroult furnace in its South Chicago plant, and had made a variety of products therein, but the expectations of many that a great number of these furnaces would be constructed were disappointed.

Since the war began, however, there has been an extraordinary increase in electric steel furnaces. Probably this would be even greater than it has been were it not for the difficulty of getting electrical equipment in reasonable time and also to the shortage of carbon electrodes.

Francis A. J. FitzGerald

The difficulty of getting an adequate supply of electrodes and reasonably prompt delivery is a good measure of the extraordinary increase in electrometallurgical plants. Before 1914 there was no difficulty whatever in getting an adequate supply of both amorphous and graphitized electrodes. Many standard sizes could be obtained immediately from stock supplies and any standard size could be obtained in quantity in six weeks' to two months' time; but at the present time electrometallurgical processes requiring amorphous electrodes are limited by the electrode shortage. The question of electric power, serious as it is, is not of the same nature as that of electrodes. The power question is largely one of price, and consequently on account of the enormously increased prices of electrometallurgical products it is now possible to pay power rates that would have been considered ridiculous before the war. In the case of electrodes, however, it is at present impossible to obtain prompt deliveries at any price.

It is a matter for regret, so far as steel is concerned, that there has not been a development of the use of the induction furnace or the Röchling-Rodenhauser modification in this country. Furnaces of this kind are used very largely in Europe and are of course independent of the electrode supply. On the other hand, it is possible that even if we had a number of these in use the shortage of magnesite would be troublesome.

One result of the war as regards electric steel-making seems to be pretty certain; no sane person will construct a crucible steel furnace plant hereafter. The pendulum is swinging from crucible steel toward electric steel, due to similar economic conditions which recently caused the culmination of Bessemer capacity.

The shortage in the graphite supply and in the German clays used in making crucibles, with the resulting poor quality and high price of crucibles has stimulated greatly the desire for a good electrically-heated brass melting furnace. So far as bronze and copper is concerned there seems to be a satisfactory solution in sight, some good reports have been made on the use of the Rennerfelt furnace for this work. But the melting of brass still presents a difficult problem. The successful use of any form of arc radiation furnace for this purpose seems doubtful, and we must wait to see what can be done as a result of Clamer's and Hering's work on induction and pinch effect furnaces, or of Gillett's experiments.

The ferro-alloy development has been astonishing and everyone seems to be rushing into the manufacture of ferrosilicon as a result of the sensational prices that have been quoted for that material. High prices have undoubtedly resulted in turning over the use of a good deal of furnace capacity hitherto used for calcium carbide manufacture to the production of this material.

Another most interesting development is the manufacture of ferromanganese in the electric furnace. This has often been considered in previous years, but the low price of 80 per cent ferromanganese has formerly made its electric production unattractive. Now, however, things are very different and this has stimulated the electric furnace method in a wonderful manner.

Another new and interesting development is the production of basic pig iron in the electric furnace using high-grade steel scrap as a raw material.

The increase in furnace capacity for the production of artificial abrasives has been enormous. This is, of course, largely due to the increased demand, but also to the cutting off of the supply of Naxos emery. The consequence is that electric furnaces making aluminous abrasives and carborundum, which produced 62 per cent of the total abrasives used in the United States in 1914, have further experienced a great increase in number and output.

Americans may well feel proud of the way in which their manufacturers have met this situation, but at the same time it is with bitter regret they see in this case the continued exile of this distinctly American development to foreign countries, caused by the folly of the Washington politicians in the matter of water power legislation.

Niagara Falls, N. Y.

Aluminium

By Jos. W. Richards

To write anything satisfactorily upon the past, present and future of aluminium in a few words is not an easy task. Most readers of this journal are familiar with the beginnings of the industry, about the time of the invention of the Bessemer process, the middle of the last century. But the great hopes of Deville were never realized, the infant industry in France remaining an infant for twenty-five years. The industry began to grow into a promising youth in 1890, with the rise of the Hall process, and reached manhood strength and development only with the beginning of this century. The center of the industry has moved from France to North America, and of the nearly 100,000 tons produced annually, the United States figures for approximately two-thirds.

Jos. W. Richards.

The sources of raw material, bauxite, have not changed much in many years. France has the largest deposits, and really still exerts a controlling influence upon the industry in Europe from her command of the raw material. Purification of the raw material is essentially a manufacturing chemical operation, and has developed largely in the United States, Great Britain, France, Belgium and Germany.

Reduction of purified alumina to metal is an electrolytic operation, requiring large amounts of cheap power. In this matter, countries like Canada, Norway and the Alps possess great advantages, and the final step of reduction gravitates toward these countries. Norway in Europe, and Canada in America, loom up as the future centers of aluminium production, but are dependent upon other countries for their supply of the raw materials. Most of the large companies are therefore international in scope, working the mines in one country, purifying the raw material in another, and producing the metal in still another.

As a war material, aluminium finds many uses. Aluminium time fuses for shrapnel are used in place of brass, several million having been put into shells made in the United States for the Russian Government. Several thousand tons of aluminium wire have been used in the point of the modern long-tapered rifle bullets—the copper-nickel sheath has a small pellet of aluminium inserted in its point, the remainder being filled with lead. This gives a flatter trajectory and increased accuracy of fire. Machine guns of the air-cooled type use aluminium radiators. The explosive "ammonal," consisting of powdered aluminium and ammonium nitrate, is being used in large quantities by all combatants in the present war. Aerial construction has absorbed large quantities of aluminium. Each large Zeppelin contains about 9 tons of aluminium framework.

There is no longer any question of the status of aluminium as an "every-day" metal. Its use for cooking utensils has made it a household friend, and this still figures as its largest potential use. In automobiles it is a necessity, and almost one-third of all that is made is thus consumed. It is now a common, useful servant of mankind in a thousand ways undreamed of twenty-five years ago. Its introduction into common use has been one of the great achievements of the nineteenth century.

Since the outbreak of the war it has become increasingly difficult to get statistics of any reliability concerning the course of the aluminium industry. Even the promoters of the industry in America profess ignorance regarding the development of the industry in Europe.

It can be assumed with considerable confidence, however, that the industry has prospered greatly and increased in output except in Switzerland and Austria. In these countries, the producing company is controlled by German capital and a larger part of the product was shipped to Germany, while the alumina consumed was obtained mostly from the bauxite deposits of the south of France. This source of supply of alumina has naturally been cut off by France, leaving the Central Empires dependent upon their own sources of alumina. The industry in the United States has meanwhile developed handsomely.

It is important to note that while recent quotations were 55 to 65 cents per pound for odd lots, during 1916 the Aluminum Company of America supplied the bulk of the domestic consumption at 27 to 33 cents per pound. This was in consonance with a policy to supply the old customers at the same rates as prevailed in 1915, unaffected by the European demand. The Aluminum Company of America deserves great commendation for the combination of good business sense and intelligent patriotism shown in thus sparing the consumers of aluminium in this country the great hardships which a narrower business policy might have imposed.

What of its future? Its use and its usefulness will continue their rapid rate of increase; it will become cheaper after the war, and will rank with the half dozen metals most useful to mankind. The present output of 100,000 tons yearly will reach 1,000,000 tons before the middle of the century, and in net usefulness to mankind it will stand beside copper and be surpassed only by iron and steel.

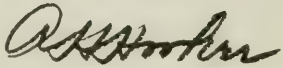
Electrochemistry

By A. H. Hooker

Technical Director, Hooker Electrochemical Company

The present war has emphasized the close relationship of chemistry to the ordinary necessities, comforts and luxuries of life, to say nothing of their vital importance in the materials of war, whether these materials be motor trucks, hospital supplies, guns, bullets or explosives.

The importance of the Niagara Falls industries to the present needs of our country, the calamities which might result from any curtailment of the power used by these industries, and the general public good which could result from a greater conservative use of this power, is best illustrated by a consideration of the uses made of some of the products so produced.



Phosphorus and phosphorus compounds are essential components in every match, the highest grades of bronze and copper alloys, in fire-carrying anti-aircraft bullets, and in liquid fire. Chlorate is equally important in the manufacture of matches and the fulminate cap, without which not a mine, cannon or rifle can be discharged.

Calcium carbide produces the acetylene gas for lighting the isolated country home, the small village and the automobile, as well as for flares, buoys and headlights. The cutting of armor plate, the building of our ships and steel structures, the repair of war's wastage requires the oxy-acetylene flame.

Carborundum, alundum and other electric furnace artificial abrasives are of the utmost importance in all the metal working industries. Without these the manufacture of motor cars, rifles, all kinds of machinery and equipment would be curtailed tremendously, and the expense of manufacture increased many fold.

Sodium is the basis for the production of cyanide, upon which depends the extraction of a large part of our gold and silver from the ore. Sodium peroxide is the starting point for hydrogen peroxide bleaching agents and disinfectants, and the source of oxygen for rescue helmets and hospital aid. That Chloroform is a necessity in surgery needs no argument.

Artificial graphite as electrode material is absolutely indispensable to the industries producing caustic soda, chlorine, and in the refining of steel. Every time a flash light gleams, a self-starter operates, or a telephone call is answered, think of the artificial graphite in the battery which makes it possible. As a lubricant deflocculated graphite fills a field which cannot be taken by any other material.

Caustic soda is essential for the manufacture of soap, the refining of petroleum and the production of gasoline. As a strictly war material it is required for the manufacture of nearly all explosives as a neutralizing and fusing agent. It is equally important in the production of synthetic dyes and medicines.

Chlorine is a many sided substance, beneficent and devilish in turn. As a sterilizing agent it purifies the drinking water of our cities and camps, preventing typhoid and other water-borne diseases. It is the basis of the Carrel-Dakin solution, that wonderful antiseptic dressing used on the battlefield. As a poison gas, we all know of its fiendish effects upon the soldiers in the trenches. Combined with calcium it forms bleach without which our paper mills and printing establishments would be bare of book and writing papers; it is also necessary in bleaching cotton fabrics. Chlorine, combined with such coal tar products as benzol, toluol and naphthalene, plays a most important part in our rapidly developing dye and explosive industry. As an example of this, we combine chlorine with benzol to produce monochlorbenzol. This on nitration and treatment with a caustic alkali becomes dinitrophenol, the intermediate from which may be made one of our most important and fastest dyes, sulphur black, or else by further nitration, converted into picric acid, one of the most largely used explosives.

This vital electrochemical industry, which now has its great center in Niagara Falls, is seriously threatened in its present development by the withdrawal of power which has been imported from Canada. The farther development of the industry, which is so widespread in its benefits to the entire population of the country, has been arrested or sent to foreign lands, all through lack of prompt conservation and conservative development of the power which is going to waste at our door.

A large increase in our present power development is beyond question possible without a particle of injury to the scenic beauty of the Falls. This development and the growth of these industries would be of untold benefit to the nation at large, and is of particular significance at the present time when we consider the vital importance of these materials to the successful carrying out of this war, and the conservation of coal and transportation.

It would seem that now, if ever, was the proper time to consider an increased power development and the proper means of obtaining the maximum development without injury.

Niagara Falls, N. Y.

Western Sulphuric Acid

By Lewis B. Skinner
Vice-President Western Chemical Company.

In these days of acute sulphuric acid shortage, the present and possible production of sulphuric acid in the Western States becomes an interesting phase of the national situation.

The volume of pre-war by-product acid was in part dependent upon the American spelter market—the foreign metal market was so well supplied from German-controlled works in Belgium operating on Australian ores that exportation was small. Again, freight rates make it practically impossible under normal price levels to transport either acid or ore any great distance by rail to the Eastern and Southern States, where the acid finds a ready market.

Lewis B. Skinner

The blende roasting plants are located in the Middle Western areas, where are large supplies of cheap coal and natural gas. The available zinc ores come mainly from west of the Mississippi and Tennessee, and freight rates have determined the economic location of the smelting plants near cheap fuel, largely in Illinois.

Just previous to war times there was an invasion by the Middle West acid-makers into the peak-price sulphuric acid area of Pennsylvania.

Since the war begun, two more large zinc acid plants have been completed in the Pittsburgh district. One of the operators, the United States Steel Corporation, had formerly absorbed a very large amount of acid from other makers. Ores from Australia failing to reach Belgium are finding a very satisfactory market at these Pittsburgh plants, and it would seem as if freight rates are such as to allow of a continuation of this ore movement even in normal times.

So much pressure had been brought to bear upon copper companies in Tennessee by the United States forestry officials that the smelters, several years before war times, had made a decision to manufacture acid with their sulphur smoke. The daily American production of 60 deg. Bé. acid had been increased some 1000 tons by these installations, which by the way were made possible only because their plants were operating semi-pyritic blast furnaces on pure ores, and in a region of large acid consumption.

Preceding the war, the demands of the Pacific Coast were not very large, probably no greater than a total of 150 tons of 66 deg. Bé. per day, and that of the Rocky Mountain area farther eastward no greater than 50 tons. Such a limited quantity was easily supplied by local acid plants operating with sulphide ores mined primarily for their metal content, and whose metallurgical treatment demanded a preliminary roasting or calcining operation.

Two large plants have recently been completed by two of the leading smelting companies in the Rocky Mountains. One plant at Anaconda, Mont., is expected to fill needs created by a new metallurgical process, and the other, near Salt Lake City, is expected to furnish acid for leaching oxidized copper ores. A third plant is being built by another smelter in Arizona. The Rocky Mountain area is therefore receiving its share of attention.

On the declaration of war, acid makers expected a greatly diminished demand, especially from the fertilizer maker, who would curtail his operation since he could get no more German potash. There was therefore much surprise when the spring of 1915 found depleted stocks and an ever-expanding market. Spurred on by this condition almost every manufacturer has increased his producing ability by various refinements in process and other expedients, until to-day I estimate there is a legitimate plant increase of 50 per cent over that at the beginning of 1915.

Every acid maker is wondering what he will do with his plant production after the war is over. Sulphuric acid is not a commodity like brick, lumber or slabs of zinc, that may be stored on the prairie without deterioration until some change of commercial conditions makes its purchase desirable. A number of small Southern plants which have been resuscitated by their neighboring fertilizer plants will doubtless again drop out of sight when the demand slacks off. The larger concern, with its interlacing of other operations and dependency on other commodities, will probably find it impossible to adjust itself so quickly.

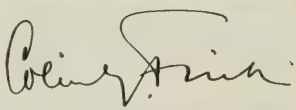
I find it difficult to refrain from the idea that the American policy of preventing any "getting together" of those engaged in similar lines of endeavor is a poor one. How much better from the political economy point of view would it be could those unfavorably situated and operated plants be stopped when they cease to have warrant for existence, and be reimbursed for their losses, thus leaving those more fortunately circumstanced to furnish the market requirements. Instead, all will try to peg along to the last, and be subjected to the purchasing agents' game of playing one against the other, with the result that the time will again come when the dollar invested in this industry (as has heretofore been indicated by statistics) shall see less return than if it were engaged in any other normal activity.

Tungsten, the Key Metal

By COLIN G. FINK, Ph.D.
President, American Electrochemical Society

The various fortunes of war are fickle, and it is a truism to say that victory finally perches upon the pennons of that side having the greatest resources of brains, men, and munitions. Since prehistoric times, however, there has been an unending struggle between various races of mankind, and in this has been a continual development of weapons and defensive armor.

Considering even the stone age, that tribe of men who had easiest access to the best deposit of flint and the necessary skill to work it was evidently easily victorious over its neighbors who had to rely upon the softer bone or horn weapons. Even the best development of flint swords and daggers and spears and arrow heads was unable to repel the invasion of another race armed with bronze side arms and shields. Yet the bronze age passed after centuries of groping metallurgy, while the ancient smith produced steel in his primitive forge and discovered how to harden it after being cunningly wrought.



The success of the disciplined Greek and Roman armies over the barbarian hordes was certainly due to their key metal, iron or steel, which tipped their javelins, ribbed their shields and formed their short blunt swords. Against such equipment of men and munitions the flights of savage flints and missiles were impotent. The middle ages witnessed the gradual perfection of the ancient war harness, culminating in the knight, armed "cap-a-pie," who now rides clanking through the pages of the story book.

Lead then became the key material, and the foot soldier came back into his own. The patriots of 1776 who tore down the leaden statue of King George tempered their patriotism with thrift, and sent the image back to its donors piecemeal in bullets.

A century later metallurgy again changed the equipment of armies upon the invention of the percussion cap, a capsule of copper held the fate of nations.

Most of the elements of the modern breechloading and magazine rifle were known at an early period, but they remained undeveloped for lack of means to do minutely accurate work. Tool development is a parallel phenomenon. Some essential properties of tungsten steels have been known for over fifty years—self-hardening steel tools were invented by Robert Mushet between 1860 and 1870. Not until the Paris Exposition of 1900, however, did the modern era in tool steel begin; then Taylor first exhibited to the astonished gaze of incredulous machinists the spectacle of a tool cutting so fast and deep that it delivered chips at a blue heat and in amazing quantities. Since that time the introduction of modern scientific shop management has been going on apace, wholly made possible by the use of these high-speed tools cutting four times as much metal as the best of the older carbon steels. Whereas in the wars of the past copper, tin and lead were, next to steel, the most important "martial metals," to-day tungsten alloyed as high-speed steel is the dominating factor. To deprive a nation of tungsten is to cripple its military power in time of war, and its industrial power in time of peace. Without high-speed steels, machine tools could not be produced nor operated in sufficient quantity to make the "seventy-five" and its thousands of shells, the rifle and machine gun and its millions of cartridges, nor could automobiles, farm machinery, ships or engines be replenished after the sword has been happily sheathed.

Germany was the only nation which properly appraised this situation in 1914. At that time, with characteristic thoroughness, she had a practical monopoly on the world's tungsten production. The mines of Burma, the world's most productive region, although in English territory, were controlled and operated by Germans and the ore shipped to Germany for treatment. The Cornish tungsten ore actually produced on the "tight little isle" was shipped to Germany for refining and then sold back to England.

At the outbreak of the war tungsten output actually declined as the German-controlled mines stopped producing, and it was not until the middle of 1915, after a year's hostilities, that England finally awoke to the importance of the situation by noting that no more tools were to be had.

Then occurred a violent speculative rise in price accompanying insistent demands of the war boards for more materials. When England at last realizes the need of a thing she goes after it, and the result to-day is that out of a total of 19,000 metric tons of tungsten concentrates (60 per cent WO_3) produced in 1916, England controlled and acquired 13,000 tons, or over two-thirds of the world's supply. Fortunately, the United States produced nearly 7000 tons of the best and purest of these concentrates in 1916, which is an earnest of our own possibilities—but it is important that these matters be well borne in mind and provided for against the time of necessity.

It may some day well be said that tungsten made democracy possible.

East Orange, N. J.

The By-Product Coke Oven

When, eight years ago, the Steel Corporation's new by-product ovens at Joliet, Ill., produced coke which made more iron per ton than standard Connellsville bee-hive coke, the doom of the wasteful bee-hive oven was sealed. Since that time, the advance of by-product coking has been a question merely of promoting a realization of relative coke values and of financing the relatively large plant investment required.

The outstanding feature of by-product coking development since the beginning of the war has been the confidence which American capital has manifested in advancing the tremendous outlay for permanent plant and equipment. With prices of all equipment soaring to undreamed-of levels, the complete plant costs twice or three times as much per oven as it cost five years ago, yet capital has shown no hesitancy. More by-product coking capacity has been installed or contracted for in the last three years than had been built in the twenty preceding years; the same capacity in bee-hive ovens would have required little more than one-quarter the outlay. Without an abounding faith in the value of by-product coke and in a lasting market for by-products, such a development would have been impossible.

By-product coking has doubled its capacity in the last three years. At the close of 1914 there was a capacity in by-product ovens for 15,000,000 tons of coke annually. Early in the year 1918, if present construction under way is carried to completion, there will be a capacity to produce 30,500,000 tons of coke per year. During these three years, 4037 ovens have been built or contracted for; their coal carbonizing capacity amounts to at least 23,500,000 tons per year, and the plant investment required has been over $100,000,000.

Notwithstanding this rapid development the United States will still be making in 1918 about half of her coke in bee-hive ovens, with entire waste of by-products. In 1914 the by-product ovens produced 32.5 per cent of the total coke, in 1915, 33.8 per cent, in 1916, 34.9 per cent and in 1917 probably about 40 per cent.

Of all the coal consumed in this country scarcely 7 per cent is carbonized with by-product recovery, while in Germany the corresponding figure is greater than 30 per cent. Germany wastes no by-products, and, due in part to that fact, she was better prepared for war in August, 1914, than any other nation.

American coke oven practice uses larger units than European. The rate of coking is also faster by virtue of high temperatures permitted by the use of silica brick. The American capacity per unit and cost per ton is thus much better. There has been a tendency however in recent years to limit the width to a balance between the most advantageous coking capacity and the wall-temperature required for good by-product yields.

America's opportunity for growth in coal by-products recovery, and in chemical industry based thereon, is greater than that of any other country. Our requirements of coke for iron production and our consumption of anthracite in house heating far exceed those of any other nation. As anthracite fails, domestic coke will replace it. By-product coke production therefore should not stop growing when the full demands of iron manufacture shall have been met.

Bee-hive coking, furthermore, will not necessarily be retained in any important degree in order to take care of fluctuation in the iron industry. The by-product coke plants can meet fluctuations in demand by varying their coking period and thus their rate of output. An excess of coke output also can be stored or disposed of at moderate prices for outside fuel purposes, in order to avoid shutdowns and consequent loss of gas and by-products. In this adaptability to steady operation with minimum labor and upkeep costs, and in the reliability and regularity of its output, lies much of the secret of success of the by-product coke oven.

The war has created an immense demand for toluol and benzol—the raw materials for the modern high explosives tri-nitro-toluol and picric acid. From a production of possibly 7,500,000 gal. of light oil in 1914, made at a dozen by-product coke plants operated by one company, the output has grown to approximately 60,000,000 gal. in three years—and all of the fifty-two by-product coke plants now operating in this country, with one exception, are equipped for recovery of benzol. Nearly 10,000,000 gal. of toluol per year are being made from this coke oven light oil.

Dyes and drugs, dependent on benzol, toluol, and coal tar crudes for their manufacture, require less than 10 per cent of the present light oil output, and are not likely to require more than that in this country for a number of years. When the war is over and the great demand for military high explosives has abated, benzol and toluol will find their outlet largely in motor fuel. Benzol containing 10 per cent toluol to lower its freezing point, is an excellent motor spirit, tried and proven, equal or superior to gasoline. With investment costs largely wiped out by war profits, benzol recovery plants can operate at a profit on gasoline prices.

Ammonia, in spite of a 100 per cent increase in production in three years, has maintained a rate of price advance commensurate with that of other commodities devoted to peacetime uses. The demand it enjoys for use in fertilizers, in the chemical industries, and in safety explosives is constantly increasing—faster than the supply can meet it.

In view of the almost unlimited field for the use of by-product gas, the rapidly widening application of coal tar and its products, and the prospect for the finding of new uses to absorb the present surplus of pitch and naphthalene—there can be no question of the disposal of by-products from the rapidly expanding industry.

Although the war has brought very large increases in the demand and price for certain by-products, this has not been the main factor in the recent remarkable growth of by-product coking. War profits alone, with their uncertainty of duration, could not justify the great investment in these large permanent plants. Rather has it been the confidence in the permanent value of the plants and their products, and the great influence of an abundance of available capital, supplied by the prosperity of the American nation.

Readers' Views and Comments

A Reply to the Criticism of the Chemical Exposition

To the Editor of Metallurgical & Chemical Engineering

Sir:—In his letter to the editor of Metallurgical and Chemical Engineering, published on page 206, Sept. 1 issue, Mr. G. A. Roush apparently charges that because three exhibitors in the Second Exposition of Chemical Industries neglected to supply information or material requested, that the entire exposition was a failure. Such a statement is unjustified.

Mr. Roush has failed to appreciate the larger purposes of the exposition to show the progress made in the industries it represents, to indicate where progress can be made, how through efficient equipment and materials production can be increased or costs reduced, to show where and what opportunities await development, and how our natural resources can be made valuable and useful.

An exposition is the sum total of all its exhibits. In the Second Exposition there were 187 exhibitors. Through some apparently sinister circumstance three of these failed to fulfill the three particular things Mr. Roush had in mind in visiting the exposition. He seems to conclude from this that the entire exposition was a failure. This is the first occasion where we are informed that the sum is equal to any of its parts. Upon this same basis a college or university can be judged a failure because a graduate from one of its courses fails to come up to the standards of some individual.

This is the first criticism we have heard, and when sufficient consideration is given to the fact that over 80,000 people attended the Second Exposition, and were of the opinion that the exposition was a huge success from every standpoint, it cannot be denied that there is something radically wrong in this individual case.

National Exposition of Chemical Industries,
By Charles F. Roth, Manager.

Activities of an Impostor

To the Editor of Metallurgical & Chemical Engineering

Sir:—The writer thinks the industry should be advised that there is an imposter going about under various aliases who is a very plausible talker and is very well posted regarding various chemical companies and the men connected therewith.

It appears to be his practice to make an appointment by telephone, at the same time securing information which may be of value to him, such as the names of the company's officers, etc. After a short call, during which he talks familiarly about your business and your customers, he starts to leave and then casually requests the loan of ten or fifteen dollars until the following day, as he has to entertain some friends and is short of funds.

The writer was duly "touched" a short time ago by this man who was then masquerading under the name of West—this is the last seen or heard of this smooth gentleman.

Mr. West (?) is of medium height, with sparse hair tinged with grey and one of the middle teeth in the lower jaw is missing.

I might say further that one of our employees was "touched" for a loan by the same man, then using the name of "Lloyd" at the Chemical Exposition last fall. Unfortunately the writer learned too late that the party in both cases was the same man.

I hope this notice may prevent some possible future victim from being separated from his hard-earned "simoleons."

J. R. Pitman.

New York City.

Silico-Manganese As a Steel Deoxidizer

To the Editor of Metallurgical & Chemical Engineering

Sir:—In line with your "An Opportunity for Metallurgists," I want to call to your attention the fact that the Pacific Coast is already preparing to supply the needs of manganese in the shape of a new alloy, silico-manganese. When I use the word "new" I do so guardedly. This alloy has been used quite extensively in Europe, and just to a very limited extent, prior to the war, in the United States.

The State of California holds extensive low-grade manganese deposits, high in silica and low in other impurities, which lend themselves readily to the manufacture of silico-manganese.

Silico-manganese of an analysis containing approximately 60 per cent of manganese and 20 per cent silicon, should be a most acceptable alloy to the steel manufacturers, since it supplies the two alloying metals, manganese and silicon, in proportions much desired by the steel metallurgists.

Silico-manganese, of analysis as outlined, can be obtained for a price considerably less than that of ferro-manganese, at the present time, and eliminates the double freight charges on ferro-manganese and ferro-silicon, as well as the double handling of these two alloys at the open-hearth furnace.

J. W. Beckman.

San Francisco, California.

A Suggestion on Patent Litigation

To the Editor of Metallurgical & Chemical Engineering

Sir:—There has been much said about patents, patent litigation, and its effects on industry. This is especially pertinent at present. What is needed now is something practical and applicable to war conditions. I will therefore offer my suggestion.

Suppose there is a real-estate litigation. I believe this has been proved by experience to be best handled before a jury in open court.

Now, a patent is a title to *intellectual real estate*—otherwise called invention.

It therefore seems to me that the way for our country to handle a patent suit might be to follow the rules promulgated for Federal practice by our Supreme Court in the fall of 1913 and to superimpose on this a jury of engineers, technologists and inventors, twelve good men and true and the peers of the litigants. Most of us

to-day know something of patent law, and with the evidence all prepared, with oral examinations so that the jury could tell by manner and voice which expert was trying to dodge and which was sincere, brief and earnest, and with a Judge asking questions and expounding the law, a final and just decision could be easily obtained in a minimum of time.

It seems that in the future, say for the next five or ten years, there will be extraordinary progress in invention, research and applied science, and that some truly efficient way to get results in patent litigation must be attained. If one-tenth the mental, spiritual and volitional energy that is now wasted in our country in fighting with each other and in the honest men fighting the grafters, could be applied in Flanders, K. W. would be dethroned, die Deutsche Republik formed, and aforesaid K. W. would be applying for a job as doorkeeper in our Wall Street District.

The above suggestion is given in a tentative manner in order to help settle a most important matter and one affecting the progress of our militant industries and our successes in arms. This war may be a long one. It will be won by inventions. Inventors, while not grasping, expect pay for their work. Above all, the uncertainty and resulting indecision that comes from our present troubles in the courts could be prevented.

In these premises, I might say that *au fond* our patent laws and patent practice are not so bad as usually regarded; in fact, are quite good. It seems to me simply that the ways and means are not well applied. Nor are champertous patent lawyers entirely unknown. What is needed right now is a strict enforcement of present rules and procedure, fewer patent lawyers and more good ones.

My suggestion might well take the form of a court of arbitration established by our national technical societies. The experience of Denmark with a court of arbitration of business men in general civil cases, would lend weight to the proposal. In this Danish court, the findings are so clear, so honest, and so intelligent that the decisions, though quick, are practically never appealed.

All the above is given in outline and in syllogistic form. For its brevity—and it may be considered even witty if brevity be the soul of wit—no apology is needed in a time when words are at a discount and only sell when they conduce to action.

WOOLSEY MCA. JOHNSON.

New York City.

Antimony in Zinc Electrolytes

To the Editor of Metallurgical & Chemical Engineering

SIR:—I am enclosing description of materials and a method for determining antimony in zinc electrolyte solutions which may be of assistance to other chemists, as we have used it successfully for three months. I believe it is considerably shorter than most of the methods being used on zinc solutions.

The materials required are:

1. Buechner funnel, large filtering flask, filter pump, H_2S generator, 2000 cc. beakers, 250 cc. beakers, fine filter papers (similar to Munktell's Swedish No. 0).
2. HCl and H_2SO_4 free from As and Sb; granular $KClO_3$, $HNaCO_3$, or HNH_4CO_3.
3. Na_2SO_3 solution, about 5%.
4. Pure Na_2S solution, about 3%. Iron may be removed by allowing the solution to stand two or three days in sunlight, and then filtering.
5. Standard iodine solution containing 2.12 gm. iodine per liter, dissolved with KI. 1 cc. = 0.0010 gm. Sb. Standardize against $Na_2S_2O_3$ solution (5 gm. crystals per liter; Cu × 0.9454 = Sb). If preferred, the iodine may be standardized against an antimony solution prepared as follows: Take 0.120 gm. of pure Sb_2O_3, and 200 cc. of the Na_2S solution and heat until dissolved, dilute to 1000 cc. and filter. 10 cc. of this solution contains 0.0010 gm. Sb. 50 or 60 cc. may be heated, treated with $KClO_3$ and HCl and finished exactly like the assay, as detailed below.
6. Starch indicator: Take 500 cc. of a cold saturated solution of NaCl, filter, add 100 cc. of 80% acetic acid and 3 gm. of starch. Mix cold, heat and boil until nearly clear. Add about 30 cc. water, cool and place in a bottle. This solution will keep indefinitely.

The following is the method of making the determination:

Take 1000, 1500, or 2000 c.c. of the solution to be analyzed, add enough H_2SO_4 to make about 10 per cent acid by weight, heat to 80 deg. or 90 deg. C., and pass in H_2S for 30 to 40 minutes. Filter by suction on Buechner funnel, using double filter papers. Wash well with warm H_2S water acidified with H_2SO_4, to remove all zinc.

Remove the filter paper, fold it as usual and place it in an ordinary funnel, with one fold extending diametrically across to expose all of the precipitate. Wash with about 30 c.c. of the hot Na_2S solution, at first pouring part of filtrate through the paper again. Wash twice with hot water. The CuS remaining on the filter may be dissolved in small volume of hot 1:1 HNO_3 and copper determined by the iodide method. For solutions containing much copper, the paper containing the Sb_2S_3 and CuS is best boiled with Na_2S solution and filtered on a separate paper (S & S No. 597).

Heat the filtrate nearly to boiling, add about 0.2 gm. $KClO_3$, stir to dissolve, add 15 c.c. of strong HCl and boil for a few minutes. Allow the solution to cool one minute, add 5 c.c. of the Na_2SO_3 solution, and boil for 5 minutes. Allow it to cool one minute, and treat again with 2 or 3 c.c. Na_2SO_3, and boil. Repeat this operation once more and then boil 30 minutes to remove SO_2. (Repetition of this reduction is almost always necessary, especially if more than 0.005 gm. Sb is present.)

If more than a trace of arsenic is present, the solution should be evaporated to 10 c.c. to remove it.

Cool the solution, make it slightly alkaline with ammonia, then slightly acid with the starch indicator containing acetic acid. Cool again, make up the volume to about 100 c.c., add an excess of $HNaCO_3$ or HNH_4CO_3, and titrate immediately with iodine to a permanent blue color.

With care and the use of pure reagents, the limit of error should be less than 0.0003 gm. of Sb. Complete assay requires less than 3 hours.

For high Sb, it might be well to add a little tartaric acid after the first treatment with Na_2SO_3, but we have never found it necessary.

In working out this method, much assistance was obtained from Scott's Standard Methods of Chemical Analysis (D. Van Nostrand Co.), Prescott and Johnson's Qualitative Chemical Analysis, and Low's Technical Methods of Ore Analysis.

H. F. BRADLEY.

Park City, Utah

Coming Meetings and Events

Third National Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 24-29, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

Technical Association of the Pulp and Paper Industry.—Joint meeting with the Technical Section of the Canadian Pulp and Paper Association, Holyoke, Mass., Sept. 27 to 29, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Western Metallurgical Field

Smelter Investigation in Colorado

One of the "set pieces" at Colorado's legislative sessions for some years past has been a bill providing for the investigation of smelting concerns doing business in the State. Generally, it has been conceded that these measures, in the main, have been directed against the American Smelting & Refining Co. by legislators from the mining districts, who introduced them largely for political effect and for home consumption. In any event, none of them ever became law, and all met the customary finish in committee rooms. All were inspired by the vague notion that the smelter trust was robbing the miner in high treatment charges; and the legislators usually took their cue from a few shippers of small consequence, who, however just their cause, were not sufficiently conversant with the business to analyze it and get to the root of the matter. This is not to say that there were not reasons for dissatisfaction, for there were; but the proposed remedies were poorly conceived, by men who failed to recognize, first of all, that smelting is a highly technical business, which cannot be legislated upon without some knowledge thereof. Further, the industry is in the hands of comparatively few men, so that knowledge of its inner workings is not widely spread.

It was almost a foregone conclusion that the Colorado legislative assembly this year would pay its usual respects to the smelting industry in the form of a bill for an investigation of the buying and selling of ores. Two bills were introduced, one of which was better than the other in that it recognized the technical nature of a sound investigation, and proposed a committee of experts to conduct the same. The bill finally adopted was a combination of the features of each. It provides for the appointment of an investigating committee of five, comprising two Senators appointed by the President of the Senate, and three Representatives appointed by the Speaker of the House. This committee is charged with fully investigating "the buying, selling, exchange, refining, treatment, smelting and reduction of metalliferous ores or ore concentrates, the charges, rates, schedules and returns therefor; and shall cause to be filed with the Public Utilities Commission of this State, on or before the first day of January, 1918, its complete report and findings in writing, containing such recommendations as it shall deem appropriate in the premises."

The committee was authorized and empowered to conduct hearings, subpoena witnesses, and compel the production of records and documents. The bill carried an appropriation of the sum of $15,000 to carry out its purposes.

Obviously, the weak feature of the act is a politically appointed committee, because the public has no confidence in such a committee appointed to investigate a technical matter. Herein the bill was poorer than the one for which it was substituted. The committee appointed comprises Senators Siewers Fincher and William J. Candlish, and Representatives A. P. Ardourel, D. J. McDonald and H. P. Nagel. Realizing, perhaps, the lack of technical knowledge in the committee as a whole, it secured the services of Mr. O. R. Whitaker, consulting engineer of Denver, to review its findings and aid in preparation of the report. The selection of Mr. Whitaker will place the stamp of integrity on the conclusions drawn from the data furnished him by the committee, and it is to be hoped that the information is complete.

It is not unlikely that the report will criticize the smelters in some respects and exonerate them in others. Whatever the result, it is almost certain that the entire affair could have been avoided by a more liberal policy of publicity on the part of the smelters in years past. It has seemed as though the American Smelting & Refining Co. has been particularly dense in failing to get the spirit of the times, and slow to see the wisdom of explaining many features of its business to those on whom it was dependent for patronage. Admitting that many features of the smelting business are not understood, even by those deeply concerned, there exists the greater reason for that friendly spirit of confidence and co-operation that so many corporations have found profitable. A campaign of education on the part of the smelters for the purpose of enlightening miners on some of the more abstruse features of contracts, and a policy of simplifying and clarifying the method of computing ore values, would tend to make friends. This would be a big accomplishment, because in the last analysis the smelters' great lack is friends in sufficient preponderance to nullify any agitation for an investigation. Taking the mining public into their confidence would be good business, and perhaps one effect of the present investigation will be to educate the smelters to such a policy.

Canadian Mineral Production

The Department of Mines of Canada has issued its preliminary report of the mineral production of the Dominion for the calendar year 1916, showing a total production of $177,357,454. This is an increase of $40,248,283, or 29.3 per cent, over that of 1915. The previous maximum production was $145,634,812, in 1913. The report cites the progress made during the year in establishing and increasing smelting and refining capacities, notably the electrolytic zinc and copper refineries at Trail, the construction of a nickel refinery at Port Colborne, Ont., the production of metallic magnesium at Shawinigan Falls, ferro-molybdenum at Orillia and Belleville, metallic arsenic at Thorold, and of

stellite, the hard cobalt alloy for high-speed tool steel.

Nickel was an important product of Canada during 1916, being derived from the ores of the Sudbury district, supplemented by the recovery of smaller amounts from the silver-cobalt-nickel ores of the Cobalt district, and a small tonnage of nickel ore from the Alexo mine in Temiskaming. The Sudbury and Alexo ores are reduced in smelters and converters at Copper Cliff and Coniston to a matte containing from 77 per cent to 82 per cent combined nickel and copper. This matte is shipped to Great Britain and to the United States for refining. Nickel was recovered as a by-product in smelters at Deloro, Thorold and Welland, from the ores of the Cobalt district, these sources yielding 323,418 lb. of nickel oxide, 232,450 lb. of nickel sulphate, and 79,360 lb. metallic nickel. Cobalt also was produced at the same smelters. Among important non-metallic minerals produced in the Dominion we note asbestos, feldspar, fluorspar, gypsum and salt.

The interesting annual report of Arthur A. Cole, mining engineer for the Temiskaming and Northern Ontario Railway Commission, gives data on the mining industry in the Cobalt and Porcupine districts of northern Ontario. Gold production showed a steady increase over previous years, coming from the Porcupine, Kirkland Lake and Munroe districts. Silver production from the Cobalt district fell off nearly 3,000,000 oz., but showed an increase in value of over $1,000,000 due to the rise in the price of the metal.

A feature of the report relates to the use of flotation in Cobalt, showing the following plants and tonnages:

Mill	Tons daily
Beaver	30
Buffalo	600
Coniagas	200
Dominion Reduction	200
McKinley-Darragh	200
National (King Edward)	100
Nipissing	300
Northern Customs	200
Total capacity	1830

The use of the flotation process is making available for treatment current slime production as well as old tailing dumps, aggregating a quantity of about 2,500,000 tons. Assuming a recovery from the latter of 4 oz. silver per ton, a possible profit of $3,375,000 is shown.

Copper Output at Low Ebb

With the exception of several of the independent mining concerns, ore shipments from the Butte district are practically at a standstill in consequence of labor troubles. Production at the Anaconda mine in August was only 11,175,000 lb. of copper, as compared with 12,400,000 lb. in July and 28,800,000 lb. in August of last year. Labor troubles were responsible. Production for September will be very low indeed.

The Miami Copper Company reports an output of 160,000 lb. of copper in August, as compared with 4,498,595 lb. for the corresponding month last year. During July the mine was closed on account of labor troubles. Affairs at the Inspiration Copper Company's mine are much improved. Mining operations were resumed Aug. 24 and it is hoped that the output will be back at normal by the end of this month.

Minerals Separation vs. Butte & Superior

On August 25th Judge Bourquin, in the U. S. District Court, Butte, Mont., handed down his decision and opinion in the Minerals Separation et al. vs. Butte and Superior Mining Company.

The gist of the opinion is that the defendant having admittedly used the plaintiff's patented process in all of its elements until January 7th (the time of the Supreme Court decision), cannot now avoid infringement by adding, because of that decision, an excess of inert petroleum oils. Of this Judge Bourquin says:

> "The addition of the excess oil no more adds to or changes the process, no more avoids infringement, than would the addition of milk or other useless substance not a part of the process."

It is interesting to note that the operation upon which this infringement suit and opinion is based differs materially from the operations considered in the opinion of the U. S. Court of Appeals in the Miami case. Nor is this opinion, we would take it, of quite so wide an interest to the mining public, because of this fact that the Butte and Superior use the mechanical agitation process while in the Miami case a different and much more widely used form of flotation apparatus was involved.

In the Butte and Superior case the plaintiff's patented process in all of its elements was used, except that the quantity of the oil was brought without the claim of the patent, for the admitted purpose of escaping the patent, and, apparently, with poorer results. Whereas, in the Miami case a different procedure was used, but retaining the same amount of oil as the patent, getting a better and more economical result.

As to the Butte and Superior's increase of the oil to an amount without the claim of the patent, Judge Bourquin says:

> "The evidence likewise persuades. If the excess were effective and useful and not inert, useless and harmful, it would be without the claims of the patent, would be that of the patentees abandoned to the public, and no infringement."

In the Hyde case, the record of which was before the Supreme Court, and more particularly in the Miami case, in its argument before Judge Bradford, the plaintiff laid the greatest stress upon the reduction of oil; to such an extent indeed was this emphasized that Judge Bradford, in his opinion, stated that the reduction of oil, as compared with the prior art, is so great in itself as to constitute invention, and upon that ground sustained the validity of the patent.

Judge Bourquin says:

> "The tendency *was* [italics ours] to attach prime importance to reduction in amount of oil used, when in fact this is but a necessary incident (for which there are substitutes if not equivalents) to the creation of an infinitude of bubbles that do the work."

He then says that the patent clearly states the way to create this infinity of bubbles, and that they do the work. He says that the patent clearly points the skilled operator "the infinitude of bubbles and the degree of agitation and the amount of soap or oil to produce such bubbles."

In regard to the "critical proportions" of oil, as annunciated by the Supreme Court in its Hyde case decision, Judge Bourquin says:

> "There are 'critical proportions' of any oil used in this process, perhaps not a sharp divide, but rather a

broad one, for the amount of oil to produce sufficient and efficient bubbles must depend upon many other factors, viz.: the working cell space, amount of water, degree of agitation, kind and amount of ore, and perhaps on occasion, amount of metallic content, kind of oil, etc."

He also says:

"The patent describes oil 'considerably reduced' and refers to a 'fraction of one per cent' by way of example, and some claims limit oil to such a fraction, and a limited range within it, others are for a 'small quantity,' and for that reason held invalid by the Supreme Court. With later knowledge of this suit it is doubted that such would be the decision now. It is to be observed that limitation of the patent indicates that the Supreme Court believed the process might be operated with one per cent and more of oil, and contemplated that this would not defeat the patent, but might affect infringement."

As to the air Judge Bourquin says:

"At the same time, though heretofore somewhat ambiguous and obscure, present knowledge warrants the conclusion that the gist of this remarkable and valuable process and the actual discovery and invention are that whereas theretofore in ore concentration air had been used in desultory and fugitive bubbles as a makeshift incident of and supplement to oil and skin flotation, air can be made to do all the work by creating in water, or pulp, modified by a suitable oil contaminant an infinitude of bubbles.

"It is the first of its kind and the patent sufficiently discloses it and methods to those skilled in the art."

And further on he adds:

"How the air particles are introduced into the pulp is immaterial. For introduced they are still particles and not bubbles. It is this subsequent agitation within the claims of the patent which agitates 'the mixture until the oil coated mineral matter forms into a froth' or 'to form a froth.' And it is all one whether this be applied agitation or self-agitation, the agitation set up by the air particles themselves in merely rising through the mass and thereby coming in contact with both water and oil, all co-acting to form bubbles which capture the metal."

The foregoing paragraph is of interest because of its reference to the agitation in the process. The closing sentence of the paragraph especially so, in that it would appear to be opposed to the recent decision of the Court of Appeals in Philadelphia as to the degree of agitation necessary to bring it within the claims of the patent. The question of relative agitation, however, is not an element of the Butte and Superior case, since the agitation which was used is admittedly that of the patent.

As to the new evidence, over that of the Hyde case, Judge Bourquin says:

"The great mass of new evidence herein is but cumulative of the Hyde suit. The only new publication is the California Journal of Technology detailing a suggestive but rather misleading and abandoned experiment sufficiently referred to in the Miami suit."

The defendants had placed much dependence upon this publication in the California Journal of Technology because of its absolute description, as they consider it, of the "agitation froth," its method of production and characteristics, as antedating by some years the time of the invention of the patent.

As to the weight of new evidence necessary under the circumstances, the Supreme Court having declared the patent valid, Judge Bourquin says:

"If it be conceded that new evidence might warrant and demand that a trial court hold invalid a patent by the Supreme Court held valid, such evidence must be unequivocal, clear and convincing, in quality and quantity that inspires confidence and produces conviction that the patent is invalid beyond reasonable doubt. Not only does it fail here, but it strengthens the conviction that the patent is valid."

The decision contains some interesting figures as to metallurgical results obtained by the Butte and Superior when using the process, and treating some 1,598,000 tons of ore.

YEARLY AVERAGES

Year	Material Treated, Per Cent	Oil Used, Pounds	Concentrate Grade, Per Cent	Apparent Recoveries, Per Cent
1913.....	15.14	5.58	47.60	80.03
1914.....	14.14	2.22	53.03	86.08
1915.....	13.66	1.49	54.62	90.18
1916.....	12.89	1.43	53.83	92.63

"Progress is noted by leaner ores, less oil, higher grade concentrates, and greater recoveries, all coincident with advancing time,"

says Judge Bourquin. It is not clear just what the Judge intended to convey by that comment. Such improvement was undoubtedly due more to the metallurgical attention of the operators of the process than to any particular information contained in the patent itself. The sudden necessity in which they found themselves of disarranging all that they had been doing would also, naturally, account largely for the "poorer results" of the increased oil. But we are not sufficiently familiar with the evidence before the Court even to suggest this.

The Judge's comment as to the fact that had the larger amount of oil been more profitable they would undoubtedly have found it out prior to January 7 is certainly impressive, and it is natural that one would, upon the face of it, be unfavorably impressed by any simple evasion such as the opinion sets forth.

We must now await the decision of the Court of Appeals, which may, as they did before in the Hyde case, find more in the prior art, and greater weight in the new matter, than has Judge Bourquin in his opinion.

Fall Meeting of the Paper Industry

American and Canadian Technical Associations to Meet at Holyoke, Mass.

All arrangements have been completed by the local committee at Holyoke, Mass., for the joint convention there on Thursday, Friday and Saturday, Sept. 27-29, of the Technical Section of the Canadian Pulp and Paper Association and the Technical Association of the Pulp and Paper Industry.

The business meetings will take place in Knights of Columbus Hall, Holyoke, the opening sitting being scheduled to start promptly at 10 o'clock on Thursday morning, Sept. 27. The convention will be opened by President Henry P. Carruth with the introduction of Hon. John J. White, Mayor of Holyoke, who will deliver an address of welcome. The response for the association will be made by Martin L. Griffin, of the Oxford Paper Company. The selection of Mr. Griffin is especially appropriate, as he was one of the first chemists to be connected with a paper mill in the Holyoke district.

Among the papers to be presented at the afternoon session are the following:

1. "An Investigation of Stresses in Digester Shells," by Prof. H. O. Keay of the Laurentide Company, Grand' Mère, P. Q., Canada.

2. "Clay Retention: Influence of Clay Concentration,

Alum Concentration and of Alum and Size," by Prof. John D. Rue of the Fletcher Paper Company, Alpena, Mich.

3. "Some Observations on the Retention of China Clay by Paper Pulp," by Dr. Otto Kress and George C. McNaughton, of the Forest Products Laboratory, Madison, Wis.

4. "A Review of Different Processes for Causticizing Sodium Carbonate Liquors and the Separation of the Sludge," by Martin L. Griffin of the Oxford Paper Company, Rumford, Me.

The banquet will be held on Thursday evening at the Hotel Nanatuck.

Friday, Sept. 28, will be Visitation Day, an interesting program of visits to paper mills, papeterie plants and allied industries having been provided for members and guests.

The managers of the National Exposition of Chemical Industries have set apart Wednesday, Sept. 26, as "Paper Day" at the exposition in the Grand Central Palace, Lexington Avenue and Forty-fifth Street, New York City, and members of the Technical Association of the Pulp and Paper Industry and the Canadian Technical Section are invited to call and inspect the exhibits of apparatus, machinery and chemical products used in the manufacture of pulp and paper. A representative of the Technical Association will be in attendance at the association's booth to receive visitors and give any needed information.

Program of the Chemical Exposition

The following is the program of the third National Exposition of Chemical Industries, to be held during the week of Sept. 24, 1917, at the Grand Central Palace, New York. In addition to the addresses listed below, a very large number of attractive motion pictures will be presented, the program of these being shown on page 327 of this issue.

MONDAY, SEPT. 24

Afternoon—Opening addresses.

2:00 p. m.:

DR. C. H. HERTY, Chairman, Exposition Advisory Committee.

DR. JULIUS STIEGLITZ, President, American Chemical Society.

DR. C. G. FINK, President, American Electrochemical Society.

DR. G. W. THOMPSON, President, American Institute Chemical Engineers.

TUESDAY, SEPT. 25

Afternoon—Lecture.

4:00 p. m.:

DR. ALEXANDER SILVERMAN (University of Pittsburgh),

"Glass Manufacture." Illustrated specimens and stereopticon.

Evening—Addresses.

8:00 p. m.:

DR. M. T. BOGERT, Chairman, Chemical Committee National Research Council,

"The Operation and Work of the National Research Council for the National Weal."

DR. F. W. TAUSSIG, Chairman, U. S. Tariff Commission.

"The Tariff Commission and Its Operation."

DR. GRINNELL JONES, Chemist to U. S. Tariff Commission.

"The Tariff Commission and Its Operation with Reference to the Chemical Schedule."

WEDNESDAY, SEPT. 26

Afternoon—Meeting of the Technical Association Pulp and Paper Industry.

4:00 p. m.: Lecture:

M. A. WILLIAMSON (the Norton Co.).

"The Manufacture and Use of Alundum and Crystolon."

Evening—Addresses:

8: p. m.:

MR. W. S. KIES, Vice-president, National City Bank.

"The Development of Export Trade with South America."

MR. C. H. BOYNTON, President, American-Russian Chamber of Commerce.

"Russia and Its Relation to the United States."

DR. L. H. BAEKELAND, Member Naval Consulting Board.

"The Future of the American Chemical Industry."

THURSDAY, SEPT. 27

Afternoon—Symposium on National Resources for Chemical and Allied Industries:

2:00 p. m., speakers:

MR. C. H. CRAWFORD, Assistant to President, Nashville, Chattanooga & St. Louis Ry.

"Ahoppa Awan Tewa."

MR. V. V. KELSEY, Chemist-Industrial Agent, Carolina, Clinchfield & Ohio. Ry.

"Building a Complete Cycle of Chemical Industries on the Clinchfield."

DR. T. P. MAYNARD, Mineralogist-Geologist, Central of Georgia Railway.

"Industrial Interpretation of the Mineral Resources Along the Central of Georgia Ry."

DR. E. A. SCHUBART, Mineralogist-Geologist Norfolk & Western Railway.

"The Development of Chemical Industries Along the Norfolk & Western."

DR. J. H. WATKINS, Geologist, Southern Railway.

"Railroad Industrial Preparedness."

Evening—Meeting: The American Institute of Chemical Engineers.

8:00 p. m.: Joint meeting: The New York Sections, American Electrochemical Society, The American Institute of Mining Engineers.

FRIDAY, SEPT. 28

Afternoon:

3:30 p. m.: Meeting—American Ceramic Society.

DR. MALINOVSZKY.

"Refractory and Stoneware of Malinite."

Evening—Meeting:

8.00 p. m.: New York Section, American Chemical Society.

The Engineering Council

Its Organization, Aims and Sub-Committees

The formation of an Engineering Council is the outgrowth of a real need for proper consideration of questions of general interest to engineers and to the public, and to provide the means for united action upon questions of common concern. Many such questions have come up in the past and will arise in greater number in the future. This war has brought out very impressively the actual need for united action of some kind. At present the Council is concerned only with four societies, because that seemed the most practical way of getting a group of men together to answer the immediate needs, but these societies do not assume to speak for all engineering societies in the country. Criticism that they are exclusive in any way is utterly mistaken. There is the hope that such a Council, by proving itself effective, may lead to much wider cooperation in a strictly representative body for all engineers, and thus pave the way for a very much larger union in the future.

How can the Council be enlarged? By a union of all societies, either as the outgrowth of the present Council or by a congress of engineers leading to united action by all societies. The first method will be the most natural one, because many local societies and national societies also have a large membership in the four societies at present concerned. We have three classes of engineers to reach: first, those who are members of local societies and not members of national societies; second, those who are members of national societies and not members of local societies; and third, those who are members of no society. The last named class constitutes a very large number in our profession. We are almost as mixed as American citizenship, and we suffer therefrom just as much as America with a population representing every race and every people in Europe. There can be no question of the enormous advantage of union. That union should be completed by strengthening the existing agencies and not by the formation of new societies. The national societies are thoroughly national notwithstanding an occasional complaint that they are run by New York. If they have not been able to express the democratic spirit of our country as fully as might be desired it is the fault of the members in all the states and not of the city in which the principal offices are located.

The four societies concerned at present are the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. They have come together in pairs from time to time in the past for special purposes, and there have been general conferences on subjects requiring immediate settlement, but until the Council was definitely organized in June there was no permanent body to advise all the societies. We have had many fruitful discussions in the past leading to useful action. The Standardization Committee which has been organized to represent five societies has passed upon commercial standards of all kinds. This committee has great possibilities and it should be enlarged enough so that its influence may become very widespread.

Many problems have already been presented before the Council. Its personnel made up of twenty-four men representing equally the four societies is well balanced and judicial. The first duty was necessarily the organization and appointment of standing committees, which have already been reported in the press. They might with advantage be mentioned here:

1. Committee on Public Affairs, comprising Messrs. C. W. Baker, G. F. Swain, S. J. Jennings and E. W. Rice.

2. Committee on Rules, comprising Messrs. J. P. Channing, Clemens Herschel, N. A. Carle and D. S. Jacobus.

3. Committee on Finance, comprising Messrs. B. B. Thayer, I. E. Moultrop, Calvert Townley and Alex. C. Humphreys.

Certain questions relate, however, to the war and the assistance that engineers can render. A committee to be called the American Engineering Service Committee was appointed with instructions to invite the cooperation of all engineering societies. This committee in the first instance consists of A. D. Flinn of the Civil Engineers, A. S. McAllister of the Electrical Engineers, George J. Foran of the Mechanical Engineers, G. C. Stone of the Mining Engineers and E. B. Sturgis of the Mining and Metallurgical Engineers. Its present duty is the tabulation and listing of the members of the five societies represented, in order that we as a profession may be in a position to take a larger part in the industries after peace is declared. This tabulation has already in part been done, but in a rather unsystematic and unequal way. It is hoped that the new committee by having additions from other societies may make a final and lasting tabulation of all the engineers in the United States. The list is to be kept in the Engineering Building for general use in Government problems and in the industries. At present the committee is devoting its attention to the immediate need of the hour, namely, the procurement of men for special service in the Government. A list of specialists in the societies has already been completed. There are three methods by which engineers may enter United States service: first, through some organization; second, through individual application to a department of the Government; and third, through selection by the Conscription Law. But this is war service wholly and not civil service, which is the same now as it has always been. As a matter of fact, a great many engineers have already entered through the engineering societies, through colleges and through various special boards in Washington. The importance, however, of a complete list of engineers and their professional specialties cannot be over-rated. Such a complete list can be made only with the help of the local as well as of the national societies. The committee mentioned above is organized with George J. Foran as chairman and A. S. McAllister as secretary. All societies should respond to the request for co-operation.

Another committee, of which Harold W. Buck is chairman, is called the War Committee of Technical Societies. The members are Messrs. H. W. Buck, A. M. Greene, R. N. Inglis, C. R. Corning, G. C. Stone, D. W. Brunton, J. M. Boyle, J. V. Davies, Joseph Bijur, A. S. McAllister, W. D. Richardson and Charles Baskerville. It was appointed to assist any organization in Washington, such as, for instance, the Council of National Defense, the National Research Council and the Naval

Consulting Board, in any way in which it can bring to the attention of the engineers of the country the necessity for thought and help in the numerous problems that arise.

A council organized by the enlargement of the present Engineering Council can be very effective in many ways without interfering with the autonomy of any individual society. Every society has some definite purpose of its own, and also some which it holds in common with all other societies. One of the latter purposes relates to public service and to co-operation. To the end that all societies may understand fully their opportunity, the committee of which Mr. Foran is chairman has made a complete list of all the societies and their officers, and communications will be sent out inviting co-operation, and it is hoped that the Council may be successful in arousing sufficient interest to bring about a larger and better Council for all engineers.

In organizing the Council provision was made for the election to membership of other national engineering and technical societies. There is no doubt that rules can be made under which these societies may become members. This will involve consultation and discussion in the future.

The office of the Council will be in the Engineering Building, 29 West Thirty-ninth Street, New York City.

(Signed) IRA N. HOLLIS, Chairman,
Worcester Polytechnic Institute, Worcester, Mass.
CALVERT TOWNLEY, Secretary,
115 Broadway, New York City.

MEMBERS OF THE ENGINEERING COUNCIL

United Engineering Society—Clemens Herschel, B. B. Thayer, I. E. Moultrop, Calvert Townley, secretary.

American Society of Civil Engineers—John F. Stevens, George F. Swain, vice-chairman, Fred H. Newell, Alex. C. Humphreys, John D. Galloway.

American Institute of Mining Engineers—P. N. Moore, S. J. Jennings, B. B. Lawrence, J. Park Channing, Edwin Ludlow.

American Society of Mechanical Engineers—Dr. Ira N. Hollis, chairman, John H. Barr, Charles Whiting Baker, Arthur M. Greene, Jr., Dr. D. S. Jacobus.

American Institute of Electrical Engineers—H. W. Buck, vice-chairman, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

Record Production of Fluorspar in 1916.—American mines broke another record last year in the production of fluorspar, as shown by statistics compiled under the direction of Ernest F. Burchard, of the United States Geological Survey, Department of the Interior. In 1916 the shipments were 155,735 short tons, valued at $922,654, an increase of 14 per cent in quantity and of 21 per cent in value over the shipments of 1915, heretofore the record year.

The increased demand for fluorspar has come largely from the manufacturers of open-hearth steel, who use the mineral as a flux, but the demand for it in other metallurgic operations and for the manufacture of hydrofluoric acid has been very active. One of the newer uses for fluorspar is as a reagent in the recovery of potash from feldspar and from Portland cement clinker.

Russian Engineers in the United States

Having in view the coming development of the natural resources of Russia in the very near future, the Russian Provisional Government has sent a special delegation to the United States, entrusting it with the task of investigating the conditions existing in the mining and metallurgical industries of this country, as well as the laws relating to the discovery, ownership and development of mineral resources. The commission is headed by Mr. Fedor M. Foss, member of the Bakhmeteff Mission as the representative of the Ministry of Commerce and Industry. Mr. Foss is a mining engineer and director of several mining and metallurgical works in the Ural Mountains, notably Count P. P. Schouvaloff's Lyssvensky properties, producing charcoal iron, tin plates and platinum, and the Upper Issetssky works, producing iron and copper. Mr. Foss has as associates on the commission the eminent geologist Ivan M. Goubkin, who is a specialist in petroleum, and another member of the geological committee, A. A. Snietkoff, a specialist in questions pertaining to coal. Alexander Stepanoff is secretary.

The commission has entered the United States as the leading nation in their development of national resources. They feel that the most modern and economical developments of mining and metallurgy can be found here. Also in such matters as geological surveying, investigation and land classification the United States stands pre-eminent. The Provisional Russian Government therefore felt that it would be most suitable to study all these questions in the United States.

The commission has already been in Washington, where the Geological Survey and Bureau of Mines have opened their records for examination, and have aided the members in every possible way, planning an itinerary covering the entire country, so that Messrs. Foss, Goubkin and Snietkoff can see the work on the spot.

The commission intends to stay not less than four or five months, during a large part of which time the individual members will visit various localities of most interest to them. In the near future they plan upon inspecting the steel works of the Pittsburgh district, the anthracite fields of Pennsylvania and the Michigan copper country. Following the St. Louis meeting of the Institute of Mining Engineers, they intend visiting the oil wells in Oklahoma and the mining and metallurgical centers of the Mississippi Valley and the Rocky Mountains.

Upon returning to Russia, Mr. Foss will present a report to his government, reciting his findings as to the applicability of American methods to Russian problems. While it is yet early in his investigations, Mr. Foss feels at present that it would be of very great advantage to his country if American capital, engineers and plants could be bodily transplanted to Russia by the granting of the necessary concessions. These plants, operating on the most modern ideas, would then be accessible places in which to school Russian engineers, who in turn would spread over their entire country, building new works and developing new processes from this foundation.

The mining, metallurgical and chemical engineers of the United States gladly welcome these brother engineers, and will be more than happy if our work and ideas may be of help to them.

Sixth Annual Safety Congress

The sixth annual safety congress of the National Safety Council was held at the Hotel Astor, New York City, on September 10th to 14th, inclusive. One of the special features of the congress was an exhibition of devices and appliances pertaining to accident and fire prevention, and sanitation, held during the same week at the Grand Central Palace. This was the largest and most complete safety exposition ever held, and was the center of interest of a large attendance of engineers and managers interested in safety work.

Several general sessions of the entire membership were held thru the week, when topics of general interest were discussed by leading personages, such as **Hon. William B. Wilson,** Secretary of Labor; **Dr. Charles P. Steinmetz, Miss Ida M. Tarbell,** and **Dr. Adrian V. S. Lambert,** of the Rockefeller Institute. An imposing list of papers on various phases of human conservation was presented in various sectional meetings, subdividing the membership into the following distinct groups:—Public Safety Division, Public Administrative or Governmental Division, Health Service and Industrial Relations Division, Transportation and Public Service Division, and the Industrial Division. The Transportation Division was subdivided into four sub-sections, viz.: Electric and Street Railways, Marine and Navigation, Public Utilities, and Steam Railroads. The Industrial Division is formed by the following sub-sections:—Chemical and Rubber; Logging, Lumbering and Woodworking; Metals and Metallurgy, including Foundries, Iron and Steel Works; Mining and Quarrying; Automobile Manufacturing; Car Builders; Paper and Pulp; and the Textile Trades. The scope of the activities of the National Safety Council, and the wide influence of this convention can be appreciated after a mere statement of these separate meetings held during this busy week.

The Chemical Section met on Wednesday, Sept. 12th, under the chairman, **Mr. J. R. de la Torre Bueno,** of the General Chemical Company. **Dr. John S. Bates,** of the Imperial Munitions Board of Canada, gave a most interesting talk on "Manhood Conservation in Munitions and Chemical Plants in Canada." **Mr. R. G. Griswold,** of the E. I. Du Pont De Nemours Co., then addressed the section on "General Dangers from Strong and Mixed Acids, from the Safety Man's Point of View." Mr. Griswold pointed out that the average workman has no appreciation of the serious results that may arise from contact with strong acids. Pipe fitters, for instance, become exceedingly careless and neglect the essential precaution of first making sure the line under repair is thoroughly drained. Even then it should be insisted that he cover his skin with vaseline, and use goggles, rubber mask and gauntlets, in order to make sure of protection against drip and spirits. Showers, sprinklers or water buckets should be at every hand to deluge any man burned with acid. Nitric acid and fuming sulphuric acid fumes have a caustic effect upon the mucous lining of the respiratory organs, and men in contact with them should be required to wear a first class respirator fitted with an appropriate absorbent filter.

Mr. E. Fiesinger, of the Semet-Solvay Co., discussing "The Hazards of Caustic Soda Manufacture and Use," said that the solid caustic soda and liquor of more than moderate strength, especially if hot, attack the clothing and quickly burn the flesh. Goggles, rubber puttees, rubber or canvas-covered leather shoes on wooden clogs should be insisted upon. The best antidote for a caustic burn is a 2% acetic acid solution, which should be kept in cabinets on each building column, together with a supply of carron oil, which should follow the acetic acid in severe burns. Carron oil is a mixture in equal volumes of filtered lime water and raw linseed oil. *No absorbent cotton* should be used in cleansing these burns.

Dr. R. W. Chaffee, Staff Physician of the Solvay Company, read a short paper on the "Prevention and Treatment of Cases of Poisoning by Tri-Nitro Toluol and Picric Acid." Dr. Chaffee recommended a strict physical examination of all applicants for work in such plants, and a course of instruction in the nature and danger of his work. A complete change of clothing on coming to work and absolute cleanliness is prerequisite to the maintenance of health. Rubber boots, coats and gloves should be furnished. Thorough plant ventilation is essential. At the first symptom of TNT poisoning the employee should be put into light outdoor work on garden or farm under careful supervision and medical treatment, which must continue some time after recovery to prevent a relapse. Fumes should be combatted by ventilation, good retort construction and respirators. Several thicknesses of fresh cheese cloth saturated with sodium bicarbonate is an excellent respirator. The "itch" which follows contact with picric acid is speedily removed by a few days' change of work.

A paper on "Packing and Plant Handling of Hazardous Chemicals, with Special Reference to Returned Empties," was read by **N. A. Laury,** of the General Chemical Co. Mr. Laury thought that the best general package for acid is the standard wood-packed glass carboy, if made of approved materials. Mechanical handling is much to be preferred; two sticks under the side cleats handled by two men is cheaper and much safer than direct handling. Roller skids should be used in most cases. The safest practicable stopper is a ground glass or stoneware plate held on a tar paper, asbestos or rubber gasket, by a wire clip like a fruit jar. The greatest danger to carboys is the weakening of the wooden case by acid, but this can be eliminated by a wood preservative called "Preservol." The author concluded with remarks on the safe handling of hydrofluoric acid.

The metallurgical sections of the council held no less than four meetings, at which some very interesting papers were read, which we hope to publish in full in a later issue. At the Thursday session (Sept. 13) **Mr. Frank E. Norris,** of the American Rolling Mill Co., discussed "Safe Practices in Sheet Mills." Mr. Norris pointed out that the sheet mill of fifty years ago was quite similar to the modern mill. The risks are chiefly in handling the raw material and the slippery, sharp-edged sheets. The transportation of packs of sheared sheets entails a big risk, no practical device for this service has yet been made absolutely safe. A large percentage of cuts come in handling sheets to the leveler rolls, which may largely be avoided by sheepskin gauntlets, wool outside. A light mask for workers around spelter pots has saved many splash burns. Twenty-six per cent. of all accidents happen to new men.

Boston Meeting of American Chemical Society

Important Discussions on Chemists and Chemistry in Warfare

The meeting of the American Chemical Society, held in Cambridge and Boston, Sept. 10-13, inclusive, was characterized by a great seriousness of purpose and a splendid spirit of service to the country. What the chemists are doing and will do will perhaps not be publicly recognized for a long time, but when the story is written, the immense value of the chemists' work will perhaps be better realized. A great many things that the chemists are doing were brought out at the meeting, which was the second that the society has held since the war started. The meetings, which were very well attended, were held in the new buildings of the Massachusetts Institute of Technology in Cambridge.

Tuesday Sessions

In welcoming the society to Cambridge on behalf of the Northeastern Section, **Dr. H. P. Talbot**, head of the Department of Chemistry of the Massachusetts Institute of Technology, urged everyone to give serious attention to the problems of the war. He said there was no body of men similarly situated which was capable of contributing so much as the chemists. The doctrine of economy must be preached and practised and a large supply of well trained men must be furnished to help win the war.

In his response, **Dr. Julius Stieglitz**, president of the society, said the meeting was called primarily to discuss war problems. He said the officers of the society had done considerable work in connection with the resolutions adopted at the Kansas City meeting to exempt chemists from the draft and keep them in chemical work. The burden of this work was done by Drs. Parsons, Nichols and Bogert. Dr. Stieglitz said he could foresee the time when there would be a decided shortage of chemists.

The only matter of business taken up was the election of Professor **Victor Grignard**, of the Faculty of Sciences of the University of Nancy, to honorary membership in the society. Professor Grignard is in this country as a member of a French commission and was present at the meeting. He expressed his appreciation of the honor in a short speech.

AMERICAN MADE OPTICAL GLASS

Arthur L. Day, director of the Geophysical Laboratory in Washington, gave a splendid address in which he outlined the difficulties encountered in the initiation of optical glass manufacture in America. This country had depended on Germany and France for its optical glass, the prisms, heavy lenses, etc., never having been made in this country. Last April, when we entered the war, our stocks were about used up, and none was available from France or England, as all their surplus was badly needed by their governments.

The details of the manufacture could not be obtained from England or France, as the processes were secret and not known to those governments. The Bureau of Standards and the Bausch & Lomb Co. had made a few experiments leading to the synthesis of these glasses, which was the extent of American efforts up to April. At that time a conference was held in Washington and the Geophysical Laboratory was asked to devote its time to this work.

The problem was to make out of American raw materials a tolerable glass and make it quick. On investigation it was found that there was but scanty published information on the relation between the ingredients and the refractive index of the glass. Only about one-third of the last thirty years of its development is recorded in the literature.

After careful figuring by the army and navy officials it was decided that six was the minimum number of different kinds of necessary glasses. The problem was accordingly taken up with the manufacturers, who had suitable furnaces, and a tolerable glass has been produced, but much further improvement is however needed.

Mr. Day expressed most cordial appreciation of the assistance given in the work by the Bausch & Lomb Company. The difficulties in producing the glass were first: that not enough was known of the relation between the ingredients and the optical products, as has been mentioned before. A great deal of information has now been collected on this angle of the situation. Secondly, the possible American raw materials are not well known, nor thoroughly available, and not entirely pure. For instance, iron affects the transparency of the glass and the ingredients must be iron free.

The glass making pots must not be corroded too much since American clays contain 2.5 per cent iron, as compared with 1.5 per cent. in the French clays. The importance of this is obvious when it is realized that not more than 0.02 per cent. iron should be present in the resulting glass.

A further difficulty was in securing pure potash. This requirement has been practically met by the Armour Fertilizer Works, which has recently produced a pure potash, free of sulphur and chlorine.

Mr. Day concluded by saying that in October 45,000 lbs. of optical glass would be turned out in Rochester, and that if the raw material could be obtained in a pure enough condition, a glass equal to any glass used in Europe could be made with the knowledge obtained since April.

CONFERENCE ON CHEMISTS AND CHEMISTRY IN WARFARE

The conference on Tuesday afternoon was the most interesting feature of the meeting. The society was fortunate in having present Dr. Wm. H. Nichols, Chairman of the Committee on Chemicals of the Council of National Defense, and Dr. M. T. Bogert, Chairman of the Chemistry Committee of the National Research Council. Dr. Nichols' address is abstracted very fully on the following page.

Work of the Committee on Chemicals

BY WM. H. NICHOLS

It cannot be impressed too frequently or too strongly on the minds of the American people that the war on which we have entered is one which will require the faithful services and intelligent co-operation of every loyal citizen of the Republic, male and female, until the very end. No half-way measures will suffice. We are pitted against a power which has been preparing for many years and which did not strike until its preparations were complete. With that thoroughness for which the German people are deservedly noted, assisted and guided at every step by a highly intelligent Government, which, for many years, knew what it was aiming to accomplish, and intended to be ready for any eventuality, there was probably nothing which could be foreseen by human intelligence which was not provided for when the Belgian frontier was crossed. While this was true in all fields it was particularly true in the field of chemistry, which has proved to be in many ways the most important science made use of in the titanic struggle. Many of those present will remember the striking lecture of Dr. Bernthsen, delivered during the Eighth International Congress of Applied Chemistry to an audience which packed the hall in its eagerness to learn the last, and to many the first words on the fixation of atmospheric nitrogen. Probably no one among them realized the enormous influence which the process described was so soon to have on the fate of the world. We had been accustomed to consider that nitrogen fixation was practically dependent upon the electric arc and involved the consumption of enormous electrical energy. Dr. Bernthsen's exposition of what is known as the "Haber Process" was so clear and so skillful that even those who gave it only a passing thought could see the great potentialities of employing hydrogen instead of oxygen in the fixation process. Since the date of the delivery of that lecture in 1912 the production in Germany of nitric acid and ammonia in its several forms has become colossal and it may be safe to say that without the process alluded to the war from the German side would long ago have languished from scarcity of explosives, and the fields have become barren from lack of nitrogen. It is conceivably not too much to infer that the war was not launched until the way was clear for the production of nitrogen compounds after the vast accumulated stores of Chilean nitrate had become exhausted. This is one instance of many which might be cited to show the extreme preparedness of the German nation. From my own knowledge I can say that, by comparison, the English and French were unprepared, both in men and equipment and this was thoroughly understood by their enemies. As for Russian preparation, it was carefully looked after in Berlin.

While the beginning of the war found England and France not only unprepared but almost stunned by the suddenness of the shock, they lost no time in getting under way. At first many mistakes were made, and many steps taken which had to be retraced, but fortunately no vital errors were committed. As a result of the gigantic program laid down, covering every phase of preparedness, these countries found themselves able to supply the vast armies which they organized with every article, to the last detail, needed to make them effective. This offers one of the most extraordinary examples of intelligent co-operation which the world has ever seen. It is little short of a miracle.

Promptly after the declaration of war our authorities at Washington proceeded to take steps with commendable rapidity. They have been criticized a great deal because these steps have not been more rapid, but those who are acquainted with the difficulties of the situation realize that this criticism is not merited. We are a peace-loving people and had been at peace many years. Ours is a democratic government and no one man or group of men has had such powers as will be found to be necessary before we can hope to effect an organization able to cope with the demands that will be made upon it. Our organization at present is, in my opinion, temporary. Of course, the President is and must be its head. Next to him is the Council of National Defense composed of six members of the Cabinet. After this Council comes the Advisory Commission of the Council of National Defense and the War Industries Board, whose duties are not yet clearly defined. The Advisory Commission is divided up into several committees, among them one on Raw Materials. The Committee on Chemicals is one of the sub-divisions of this, and its functions are advisory. Why one of the most abstruse of all the sciences having to do with some of the most delicate and highly refined finished products should come under the head of raw materials is hard to see, but such is the case. We chemists are accustomed to be misunderstood.

I was honored with the chairmanship of this committee and have organized it along lines which previous experience led me to believe would be efficient. The work has been divided into the following heads:

Acids, Fertilizers, Alkalies, Electrochemicals, Coal Tar By-Products, including Ammonia, Pyrites, Miscellaneous Chemicals and Phosphate Rock.

I was able to secure the service of men well known to the industry as chairmen of these sub-divisions and they in turn were fortunate in obtaining many of the best men in the industry for their special committee members. In all, the Chemical Committee with its subcommittees includes some thirty-seven men. These chairmen meet twice a month in Washington and in the interval are at work endeavoring to solve the problems of production which are assigned to them. I think you understand all the work of the Committee on Chemicals has to do with the actual materials, not with research. This latter subject is in charge of the National Research Council, the chairman of whose chemical committee is a member ex-officio of the Committee on Chemicals, thus keeping both branches in close and constant touch. The Bureau of Mines is represented by its able director.

The committee is located in inadequate offices in the Interior Building, fortunately adjoining the office of the honored secretary of this society whose services are thus easily and quickly obtained at any time. Our duties are many, some merely routine, such as obtaining information for various departments, procuring satisfactory prices for articles needed, keeping in touch with the railway commission to see that goods move as freely as possible, and many other of a like character which will occur to you. In addition to these there are many duties of a more serious character requiring much active and intelligent work. Generally speaking, the manufacturers have responded admirably and there are

many instances of sacrifices being made for which recognition is not expected and probably will not be received. It would be idle to state that there are no exceptions, but every effort is being made to produce satisfactory results without resort to higher authority. We feel confident that as the war progresses the ability of the committee will be found to be equal to the problems as they arise. If, however, it should be found that they are not we understand perfectly that we will be expected to make room for those who are better qualified. The main point is that our army and navy must be supplied with everything that the chemist can give, while at the same time our industries shall be interfered with as little as necessary. It may happen as time passes that in spite of all precaution the industries may suffer to some extent, but you can depend upon it that this will not be the case if it can be avoided by human foresight. There must come a time when this war shall end and we should be constantly preparing ourselves not only to provide its requirements while it lasts, but to meet conditions as we find them at its termination. Many theories have been advanced as to what will happen when peace once more blesses our staggering world, but I believe we should so plan our affairs that whether expansion or contraction results, we will be able to meet either conditions with a bold front.

One of our most serious difficulties arises from the unwillingness of the military authorities to recognize the wisdom of exempting chemists as a class from the draft. Almost from the beginning of our work we took up this question from various angles, realizing as we do the vital importance of keeping chemists at work in their profession not only at the present time but more particularly for the future. Our civil, mechanical, electrical, and other engineers can be made good use of at the front and not only contribute greatly to the success of our forces, but by the valuable experience obtained in their profession can improve themselves for future service at home. This is not true of chemists, with an exception here and there. Once in the army and at the front, if he be only recently out of college he is lost to chemistry forever. They are not slackers and are just as anxious as any other red-blooded young men to get into the fray, and therefore I have believed it wise not only to have them exempted from the draft, but declined in case they should enlist. Already serious trouble has come to many of our chemical plants and plants employing chemists, as a result of the draft, and unless wise provision be soon made we can foresee a condition which it will cost months to rectify. Why should we not take the advantage of the experience of our English friends who have passed through this same situation and learned that there is a large class of men who can do more valuable work behind the lines than they can in the trenches?

The one great need of any colossal organization is the complete co-ordination of all its parts. No one can claim that the organization in Washington has yet reached this stage or even approximated it. Many things are done several times over and many others needed are not done at all. I presume this condition is unavoidable at this stage of our progress but it must not be allowed to continue indefinitely. We have the utmost confidence that the President and his advisors can be relied upon to produce the required organization co-ordinated and articulated so perfectly that it will work with giant force and with little friction. This will come after politics have given place to patriotism and this will happen, I believe, when the people of the country thoroughly appreciate the fact that we are at war. In any event, I am sure the country can rely upon the 10,000 chemists of this society to do everything that lies in their power to see that the chemistry branch, possibly the most important of all, is not found lacking in either ability or patriotism.

Dr. M. T. Bogert then presented an address on the work of the Chemistry Committee of the National Research Council, reviewing their activities in the mobilization of research chemists and coördination of their investigations, both of this country and of our allies. He also mentioned their efforts in the production of cheap and portable hydrogen plants for the aviation corps, and in the absorption of hydrogen gas in the submarine battery rooms, and related U-boat problems. The most important fields of their work is in the production of poisonous gas, gas masks, gas shells, and so on. We hope to publish this address in full in our succeeding issue.

Following Dr. Bogert's address, **Dr. Roger Adams,** of the University of Illinois, told of the work which was being done there in making some of the rarer organic chemicals, badly needed by laboratories for analytical and research work. About ten men are employed and about 80 different products have been made in one- and two-pound lots.

Dr. Stieglitz then called on **Dr. Angell,** another member of the French commission, who gave an interesting talk (in English). He said it was a very great mistake to allow the chemists to go into the trenches, as was done in France, where 60 per cent. of the young chemists had been lost. It took a long time to have scientific men recognized as of value by the military authorities. The reason for this was that the officials did not know where they were needed. At the present time, however, France's laboratory and chemical manufacturing system is very well organized for war work, the government controlling practically all the explosives' manufacture. Dr. Angell said his commission had come to the United States to acquaint American chemists with what France had done in order to avoid duplication of effort and to cooperate in any way possible.

Dr. A. A. Noyes, a member of the committee appointed to investigate the nitrate situation, then told of the recommendations of the committee, which matters are discussed fully on pages 255 and 261 of this issue. He said the conversion of NH_3 into HNO_3 worked out by co-operation with the Semet-Solvay, General Chemical and Cyanamid Companies, gave an efficiency of 90 per cent., and was very satisfactory. He said no large scale attempts had yet been made to convert cyanide into ammonia by steam in the Bucher process.

Wednesday Sessions

On Wednesday and Thursday divisional meetings were held by the fertilizer, rubber, pharmaceutical, industrial, biological, physical, inorganic and organic sections. Of especial interest was the conference held by the Industrial Division, Wednesday morning, on "The Industrial Chemist in War Time."

The sessions were presided over by H. E. HOWE of Arthur D. Little, Inc., Boston, chairman of the division.

The whole time Wednesday morning was given over to a series of talks on the part of industrial chemistry in the war.

Dr. W. H. Walker head of the chemical engineering department at M. I. T., said there was a shortage of industrial chemists and that more men must be brought into chemical engineering. He said it was more difficult to start a man in chemistry than in other branches, owing to the difficulty of translating it into every-day experiences. The course is also more expensive and this is often a deciding factor. Institutions should have loan funds to help needy men, and the men should be shown more clearly the opportunities existing in the chemical engineering field.

Dr. Hildebrand of the Bureau of Standards, Washington, D. C., described the work which was being done there in the new chemical building, on war problems.

Dr. L. H. Baekeland, member of the Naval Consulting Board gave a very interesting talk on the work of the Board. The Naval Consulting Board was created to pass on inventions for the Navy. It now, however, also passes on them for the Army. The overwhelming majority of the suggested ideas are not worth much, and it has been necessary to issue a pamphlet telling the people what not to do. In suggesting new articles to be used, the questions of their economical manufacture and availability of raw materials are not considered. He said *new* explosives is not what is wanted but a good supply of what those we already know about. The experience which England had with cordite is illustrative. This explosive needs acetone which is a scarce article today in England. It would have been better to adopt an explosive needing ether, as its manufacture is easier.

Dr. Charles L. Parsons told of some of the activities of the Bureau of Mines, which has been devoting its attention to such problems as the supply of pyrite and elemental sulphur, the manganese supply, use of low grade ferromanganese, electric furnace for melting of brass, special steels, concentration of molybdenum ores, quicksilver production from low-grade ores, apparatus for oxidation of ammonia to nitric acid, production of mesothorium from monazite, and gas warfare.

Others who spoke at the conference were Dr. Charles H. Herty, who made a plea for greater publicity of chemistry, and Prof. A. H. White of the University of Michigan, who is a captain in the Ordnance Department, who said he had been most pleasantly surprised by the treatment of civilians who entered the war department. Charles F. Quaintance, secretary of the company manufacturing Coors porcelain, made a plea for a continuance of the support of American chemists of our domestic porcelain manufacturers. He said that foreign products should not be allowed to destroy our industry. Dr. Bigelow of the National Canners' Laboratory gave an interesting talk on the food situation. Professor Olney of the Lowell Textile School and Dr. Hawley of the University of Wisconsin also spoke.

INDUSTRIAL DIVISION

The regular meetings of the Industrial Division started on Wednesday afternoon. Officers elected for the next year were W. H. Walker, chairman, S. H. Salisbury, Jr., secretary. At the Wednesday afternoon session two papers were presented by Gustav Egloff, who was, however, personally unable to read them as he was called West unexpectedly. Both the papers were short, the first describing the cracking of solvent naphtha in the presence of Blau gas.

The second dealt with the "effect of pressure on the formation of benzene and toluene from gas oil."

Gas oil derived from a Pennsylvania crude petroleum was subjected to pressures of one, eleven and eighteen atmospheres at constant temperature of 700 deg. C. to form benzene and toluene.

The following table tabulates the analytical data:

700 Deg. C.			
Atmospheres pressure	One	Eleven	Eighteen
Specific gravity recovered oil	0.891	0.976	0.998
Per cent of recovered oil	13.3	25.0	18.0
Per cent benzene in recovered oil	11.3	22.3	22.4
Per cent of toluene in recovered oil	7.5	15.1	12.9
Per cent of benzene on basis oil used for production	1.5	5.6	4.1
Per cent of toluene on basis of oil used for production	1.0	3.8	2.3

A paper on "Scrubbing Carburetted Water Gas" was presented by Robert J. Moore and Gustav Egloff. This will be found elsewhere in this issue.

"The Deposition of Silver Films on Glass" was the subject of a paper by A. Silverman and R. M. Howe.

"Chars and other Decolorizing Agents" was the subject of a paper by Charles E. Coates. Dr. Coates found that by heating almost any form of carbon at a certain temperature in an electric furnace its decolorizing power was greatly increased in acid sugar solutions, and that a good decolorizing agent could be made from pine wood. He thought the decolorizing power of carbon was a function of the porosity and that this porosity was changed by heating.

Two papers, one on porcelain ware tests and on on glassware tests were read by C. E. Waters. The authors of the latter paper were Percy H. Walker and F. W. Smither.

"Potash Recovery from Greensand" was described by H. W. Charlton. He showed samples of good quality brick made as a by-product from the manufacture of potash from greensand. He said greensand was a cheaper raw material than feldspar as it required no quarrying. The greensand is digested with lime and the solution filtered and evaporated. In order to produce 1 ton of K_2O per day about 30,000 bricks would have to be made but all kinds of tile and other materials can also be made. Mr. Charlton said the process would pay on a pre-war basis.

Julius Stieglitz in his presidential address delivered Wednesday evening said that chemistry is all that has saved Germany. He urged a high tariff on dyes and drugs, and said that manufacturers should share more profits with chemists.

Thursday's Session

At the Metallurgical Symposium Thursday morning, Dr. W. A. Whitaker, of the University of Kansas, Lawrence, presided. H. M. Boylston presented a paper on "Problems in the Metallography of Steel." Elwood Haynes presented a paper on "Stellite as a Substitute for Platinum." He said that it has the same melting point and is not attacked by nitric acid, that it can be used in the arts. I. P. Parkhurst presented a paper on "Effect of Annealing Steel on Its Electrical Resistance." E. R. Weidlein presented a paper on "Sulphur Dioxide in Hydrometallurgy." E. P. Mathewson presented a paper on "Importance of Flotation;" Dr. W. D. Bancroft, a paper on "The Theory of Froth;" O. C. Ralston, one on "Chemicals Used in Flotation," and Dr. W. A. Whitaker, one on "Flotation of Zinc Tailings."

Rubber and the War

By Andrew H. King

If anything, rubber plays a more important part in the carrying on of modern warfare than it does in time of peace. War separates essentials from non-essentials, and in this way impresses upon our minds the importance of many commonplace things. Rubber is one of these. As a basic raw material it ranks next to iron. There is nothing else like it. It fills a place absolutely its own. It has no rivals. The combinations of strength, elasticity, and mobility in such wide variations are not to be found elsewhere in nature. It is firmly interwoven in our fabric of civilization.

Its influence has for the most part been constructive rather than destructive. Whether it be found in the hose of a city fire department or in the soldier's gas mask, it is a singular fact that its purpose seems to be the conservation of human life and comfort. War is the most destructive of the games humans play at. The labor of centuries is destroyed in a brief five minutes bombardment. Fortunes in shells are rained upon the enemy. An army will go to the greatest lengths to destroy enemy life and property, but it will go an equally great distance in the other direction to conserve and protect its own. This is the office of rubber. Wherever it is used it is always protecting something, keeping someone dry, shielding something from shock, conserving electrical power, preventing waste in a thousand different ways. It has done much to cushion this most brutal of games and to make it just a little more comfortable for those that play at it. We find it in every branch, and its work is always the same—conservation.

The biggest problem an army has to face is transportation.* New stores of food and munitions are constantly required. Large bodies of men must be moved rapidly from place to place. This has always been a problem. Napoleon failed in Russia because his supply trains could not get through. The influence of the railroad is well known and understood. Suppose we turn to the automobile and see what it has done. We find the motor used extensively on the battlefields of Europe. It has been estimated that our Allies have now in actual service 300,000 motor vehicles. We find them carrying everything, wounded, food, munitions, reinforcements. The battle of the Marne was saved by men who arrived by Paris taxicabs.

But the success of motor vehicles would have been impossible without the rubber tire. Nothing else transmits the tractive force so well. Nothing else rides so easily, with so little jar as the pneumatic tire. In our own country our highways take on a new importance—or rather an old importance. They are becoming once more "arteries of commerce." Trucks of all sizes, many with trailers, ply between our cities. Recent freight congestions have proved their worth. It appears that the vexing problem of long and short haul rates is to be solved by forces outside the Interstate Commerce Commission, for the day is not far distant when the railroads will not take any short haul business whatever and will concentrate on the long hauls, in which field they seems to be most efficient. The short haul belongs to the truck. Already manufacturers and stores are pooling deliveries. It remains for a few enterprising and far-sighted men to establish regular common carrier service. But even the long haul field is not inviolate. Recently an Akron rubber company installed regular Akron to Boston service. The experiment must have been successful or the fleet would not have been increased to five trucks. The running time going and return is one week. The secret of this success seems to be in the tires. These are of special extra large and extra heavy pneumatic cord construction. They plow through sand and mud roads almost as easily as they run on brick. The ordinary solid truck tire would be helpless in roads they negotiate easily. The completion of the Lincoln Highway has given a decided impetus to touring. Here again we find the pneumatic cord tire giving the best service of any in the field.

In France motor trucks are used mainly for short hauls from the railroad base to the front. But in the campaigns against Serbia and Russia the Germans used them quite extensively on long hauls. The average life of a solid tire is seldom over 2000 miles, less than one-tenth of that expected under ordinary conditions. Bad roads, shell holes, shell fragments, overloading, speeding, and all sorts of hard service in all kinds of weather are responsible. Repairs shops are scattered along the various routes.

Our Council of National Defense has estimated that an army of a million men will require between 30,000 and 40,000 motor trucks. This figure is probably low. It is not unlikely that before the war is over our army will number fully 4,000,000 men, requiring perhaps 200,000 trucks. Pneumatic tired automobiles in ambulance service, officers' cars, and motor lorries transporting whole companies with extreme rapidity, will likely number fully 100,000 more. The load which this particular branch of the rubber industry will be called upon to bear will be very heavy indeed.

The dispatch rider of a half a century ago is gone. He and his noble steed "flecked with foam" have given place to a mud bespattered streak—the motorcycle. With all our other means of communication it is still necessary at times to send written instructions. These the motorcycle rider carries with incredible ease and swiftness, over the very worst of roads and into the veriest of hells. The wear and tear upon his tires is perhaps the worst of any. The number of machines now in service with our army is not known, but bids were recently requested for 10,000 more. This is doubtless just the beginning for it is recorded that in the British army alone there are 100,000 machines in service.

FIG. 1—A SUPPLY TRAIN SOMEWHERE IN FRANCE

Figs. 1 and 3 from *Scientific American;* Figs. 2 and 5 from *Saturday Evening Post;* Figs. 4, 6 and 7 from *India Rubber World.*

But the part of the motorcycle rider is not alone to carry dispatches. There are companies of motorcycle scouts who are able, by reason of their swiftness, to perform feats impossible for Early and Jeb Stuart. The machines are often equipped with side cars carrying machine guns, thus rendering them many times more effective.

Physicians have laid most of the ills to which the enlisted man is heir, to bacteria, filth and exposure. The first two are overcome by vaccination and cleanliness, and the third by rubber. Our military leaders fully realize that a man who is dry and warm can stand most anything and do most anything. There will be no more standing unprotected all day in water up to the waist for our soldiers. In the British army hip boots for trench wear are a most necessary part of each soldier's equipment. In our army every man has either a slicker or poncho which serves him both as a rain coat and a ground sheet. Two ponchos laced together make him a fairly comfortable shelter tent. The poncho of our Allies is their ground sheet with which each soldier is supplied. The loss of these articles by troops in action is very high. It was estimated eighteen months ago

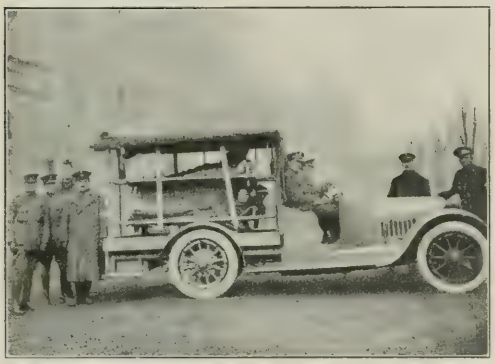


FIG. 2—AN AMERICAN AMBULANCE—UP TO THE MINUTE FOR COMFORT

that the total waste in rubber goods at the front reached fully 4000 tons daily.

Men in the motor truck service have rubber-proofed coats. Their machines are provided not only with rubberized tarpaulins but also with hoods which extend over and surround the driver's seat. Motorcycle riders are clad in a suit which is almost entirely rubber proofed. Ambulance drivers have rubber coats, boots and hats. Haversacks and knapsacks are also proofed with rubber.

This policy of protection from moisture is extended to nearly everything else. Light machine guns have their covers, as do also the delicate parts of the largest guns. Supplies of all kinds are properly protected by rubberized fabric. In this field alone rubber renders a most signal service.

The gas mask is but another illustration of the protecting nature of rubber. It has proved an effectual checkmate to German gas attacks. While a number of gases have been used it is now agreed that chlorine and phosgene are most often met with. The effects of chlorine have been known for many years, but the employment of phosgene was indeed a triumph for "frightfulness." This powerful and poisonous gas is known to the chemist as carbonyl chloride, $COCl_2$, and is produced by heating chlorine with carbon monoxide. The reaction follows:

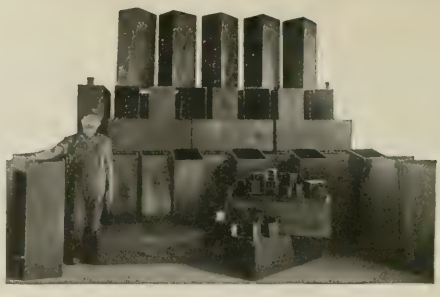


FIG. 4—BATTERY JARS FOR SUBMARINES

$$Cl_2 + CO \rightleftarrows COCl_2.$$

It is a colorless gas condensing to a liquid below +8 deg. C. At 0 deg. C. its specific gravity is 1.432, which is only a little less than that of carbon tetrachloride whose gravity is given as 1.63. Phosgene in the vapor phase is very heavy and tenacious. It is many times as poisonous as carbon monoxide and acts in much the same way, by adding on to the hemoglobin of the red blood cells, preventing them from functioning as oxygen carriers.

The gas mask is constructed upon simple lines. The hood is made of rubberized fabric and fits the head rather snugly. The eyes look out through rather large celluloid windows. A spring clamp with soft rubber buttons on the tips is provided for closing the nose, for all breathing must be done through the mouth. Incoming air passes first through a little metal box which contains the purifying chemicals, then through a hose which is connected to a rubber bit similar to that of a football player's nose guard. This bit is held firmly between the teeth. When exhaling, a little flapper valve opens and allows communication with the outside air. The life of a gas mask is not long. The gases are extremely reactive, and it is a credit to rubber chemists that it offers any resistance whatever. The outfit is neat, easily carried, and as comfortable as one could expect. The trick of breathing through the mouth is a little hard to grow accustomed to, but this is readily learned.

Another field in which rubber has rendered signal service is in the air. Rubber, while not entirely satisfactory, is still the best material for coating cloth which is to resist the diffusion of hydrogen. The gas bag of balloons is made of two or three piles of a very closely

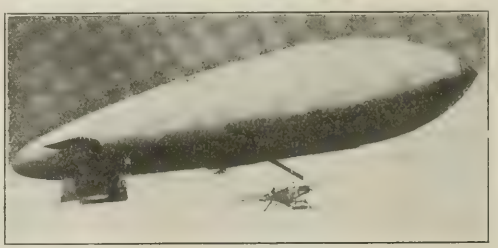


FIG. 3—A BRITISH BLIMP

FIG. 5—AN AEROPLANE IN FLIGHT (NOTE THE RUBBER TIRES)

woven and well proofed fabric. This proofing is applied by spreading machines on which the cloth receives a number of coats of rubber cement. The solvent is, of course, evaporated between coats.

Small captive balloons are used for observation purposes on sea and on land. With the advance in aeroplane practice it seems that their day is almost past.

This is not true, however, of the dirigible, called by our friends across the water "the blimp." Those building for our government have a gas bag shaped not unlike a great fish. Our first dirigible DN-1 is now fit only for training purposes. Its gas bag is 175 ft. long and has a maximum diameter of 35 ft.; 2500 ft. of double texture balloon fabric were used in its construction. Within the bag are located two balloonets, fore and aft. These interior gas bags are used in ascending and descending. To rise, the forward balloonet is emptied and the rear one pumped full of air. This disturbs the balance of the balloon, the nose is pointed up and it rises. To descend, the procedure is the same, but in this case the forward balloonet is filled and the rear one emptied.

FIG. 6—RUBBER SUIT FOR HYDROPLANE DRIVER

Sixteen dirigibles of a new type, modelled after the blimp of the British navy, were ordered by our government some months ago. It is understood that these are the first of a fleet of 300 which are to be used for coast patrol and search for enemy submarines. One of these recently made a trip from Chicago to Akron, about 400 miles, and covered the distance in sixteen hours. The advantage of a dirigible over an aeroplane as a submarine chaser lies in its lower speed. When its operators locate a U-boat, they can remain right over the place where it submerges. They will doubtless be provided with bombing devices and machine guns so as to be able to hold their ground until the arrival of the mosquito fleet. An aeroplane travels so fast that it can only say where the submarine was, not where it is. The blimps have given very satisfactory service in the British navy.

In the makeup of an aeroplane, rubber plays no small part. The wings are covered with rubberized fabric to prevent them from taking up moisture which would be simply a dead load. A very superior grade of rubber hose conducts the gasoline from its reservoir to the engine. Other hose is provided at points where the wire stays would cross. The valuable and extremely delicate instruments are protected from moisture by rubber. The machine runs along the ground on rubber aeroplane tires. On these it gets up its initial speed for the flight. When it lands the shock is taken up partly by cleverly designed rubber bumpers and partly by the tires. The insulation, which is so important, is rubber. Both the driver and his observer are protected from the cold and dampness of the clouds by rubber suits, hoods, and gloves. An apparatus which allows them to breathe in a rarified atmosphere is of rubber. They are in communication with one another through rubber speaking tubes.

FIG. 7—LATE MODEL AMERICAN DIRIGIBLE

The hydroplane, because of its contact with the sea, must be still more carefully waterproofed. The driver wears a rubber life belt, and his oxygen outfit will permit him to remain submerged for thirty minutes should he have an accident.

A modern battleship has been likened to a small city. On it are practiced all the arts of peace and war. Rubber is a prime necessity. We find the usual mechanicals—many different kinds of hose, air, gas, water, steam, armored, etc.; valves, gaskets, packing, washers; all kinds of belting; bumpers, shock absorbers for the great guns; insulation of all kinds; hard rubber knobs and handles for switches; rubber tile, matting, and rubber tired trucks. It is a floating fortress of steel. Its joints must be well packed and tight under all conditions. All that may be said of the virtues of rubber in a peaceful city applies here. The men have their rubber proofed slickers, suits, and boots for duty in stormy weather. Here again the importance of keeping the man dry is fully realized. Guns and munitions must be protected from the salt air. Floating as it does in water, there is a constant battle to keep things dry. Without rubber it would be very difficult.

Every ship in the U. S. navy has one or more divers aboard. These men are called seaman gunners and diving forms but a part of their training. Their principal

service is to examine the hull of their vessel or to recover something or other that may have been lost into the sea. The modern diving dress is made up of two parts, the bronze helmet and collar, and the elastic suit. In dressing the diver gets into his suit through the neck. There are but three openings, one at the neck and one at each cuff. At the feet the dress is attached to the heavy shoes. The dress is made of the best rubber sheeting placed between two layers of tanned twill. The cuffs are closed tightly on the wrists by means of rubber rings. There is an inner and an outer collar. The outer one is pulled over the breast plate to form a watertight joint. The helmet is screwed down upon his collar and made tight by a rubber gasket. The face plate is sealed in the same manner. The very best of hose is needed to supply him with air. It is hardly necessary to add that without rubber deep sea diving would be impossible.

In the building and operation of a submarine, rubber is of fundamental importance. It must be absolutely watertight and its packing and gaskets must be capable of resisting enormous pressures. Because of the necessity of running by electrical power while submerged the insulation problem is a big one. The interior of the boat is always damp and unless the wires and machines are adequately insulated disastrous short circuiting would result. Power is stored up in numerous batteries which must have their hard rubber jars. These are covered with sponge rubber slab to keep any electrolyte entrained in the evolved gases from leaving the jar.

Because of the extreme dampness the men are provided with rubber suits and boots. Rubber matting and tiling cover the floors and iron staircases. The periscope and other instruments are fitted with rubber bumpers and cases so as to protect both them and the operators from injury. In our navy the men are provided with rubber helmets for escape in case of accident. An important part of the torpedo is the rubber diaphragm by which its depth of submergence is regulated.

Our mosquito fleet consists of a rather large number of light fast boats which are more or less open. They must operate in all kinds of weather, consequently waterproofing and insulation are of primary importance.

Wherever electricity is used, insulated wire is necessary. Rubber insulation is still the most satisfactory material known. The best pliable insulation contains approximately 30 per cent of Hevea rubber. There are certain places, as for example, in the magneto of an aeroplane or automobile, where hard rubber insulation is highly desirable. The telegraph, telephone, and wireless telegraph are all of them dependent upon rubber for both hard and soft insulation. Electricians would be unable to handle high tension wires were it not for their rubber gloves.

In many steps of the manufacture of munitions rubber is called upon to protect the operator from serious injury. For example, in all the nitrating operations the men must be sheathed in rubber boots, aprons, and gloves. Again, a very small quantity of nitroglycerine causes an intense headache, and larger amounts may cause death. Rubber protection is absolutely necessary. When the munitions are completed rubber is called upon to keep them dry so that they may reach the field of battle in good condition. There are proofed bags for the powder and gun cotton, and rubber caps for shells.

The fine instruments, and modern warfare has developed a good many—the binoculars, telescopes, range fingers, compasses, chronometers, etc., must all be kept dry. Hard rubber often forms an integral part of them, and it is not uncommon to see their leather cases enclosed in rubber.

In the work of mercy, the care of the wounded, rubber also has its place. The soldier's first aid kit contains among other things a rubber tourniquet. The stickiness of his adhesive tape is due to rubber. The wounded man rides to the hospital in an ambulance whose floor is covered with rubber tiling. Many times he will be wrapped in a rubber sheet. The surgeons and nurses who meet him are attired in rubber aprons and gloves. He lays on a rubber bed sheet and his wounds are held together with rubber bandages. If he has fever, a rubber ice cap will cool his head; if a chill it is a rubber hot water bottle which is placed at his feet. If his wounds are serious and deep rubber tubing will carry the sterilizing Carrel-Dakin solution. If he is confined long, a rubber ring or pad inflated with air will ease him and prevent bed sores. Hard rubber enters into the construction of his physician's instruments, his catheters and syringes.

Rubber enters largely into the construction of life-saving equipment. Sailors in the British navy are provided with rubber collars which can be inflated in time of need. Cork is perhaps the most dependable, but it is bulky. A rubber life belt can be kept in the pocket and inflated when necessary. Life rafts float because of long rubber-proofed bags stuffed with cork or kapok, a silky fiber of great buoyancy.

When German autocracy crumbles, as crumble it must, it will owe its fall to four serious mistakes, all of which are directly traceable to what the athlete knows as overtraining and what the boy of the street calls "big head." They are:

(1) It thought Belgium would not fight.

(2) It thought England would remain neutral and the seas would be open.

(3) It took American patience for cowardice and decided we would not fight.

(4) It failed to appreciate the importance of rubber and to have a sufficient store laid by. Conditions are now so bad in Germany that even the wounded must do without it.

The first three we are not concerned with here. The fourth is typical of an autocracy overtrained in its own egotism. It prepared for war so effectually that it forgot to also prepare for peace. Now the penalty for being a liar is to believe the lie yourself. German propaganda spread the lie of German invincibility throughout the world, but the German himself came to believe it and this mono-mania will lead to his undoing. Rubber is so primarily a material for peace that the War Lord failed to note its importance for war.

Historians tells us that we have had on this earth of ours a stone age, a copper age, a bronze age, an iron age, and a steel age. Civilization has advanced and side by side with it, the art of war. All these materials are of such a nature that they serve both for war and peace. They are both destructive and constructive. How different it is with rubber. Its influence is preponderantly protective. The rubber industry is just beginning. Does it not augur well that the rubber age which is to come will be an age of peace?

The Mineral Industry—1892-1916

By G. A. Roush
Editor, The Mineral Industry

In glancing through the first volume of "The Mineral Industry" we find many statements and discussions that in the light of present day developments are very interesting and in some cases amusing, as no doubt many of the discussions of the present day will appear to the reader of a quarter of a century hence.*

For example, attention is called to the enormous developments that had been made in the five or six years preceding in the metallurgy of aluminium, emphasizing the fact that the price of the metal had been brought down to as low as 50 cts. per lb. and the production for the year, in the United States, was almost 300,000 lb., and the world's production almost 500 metric tons. The article closes with the statement, "It is doubtful if the further prosecution of the electrical methods, by which alone aluminium is now made, will bring the cost of it to the point at which it will become a prominent metal, unless they proceed along the line of direct reduction. Even here it is by no means certain that they can make it cheap enough. . . . While the electrical reduction methods are not to be condemned, those who seek by other means to make cheaper aluminium should be encouraged." Compare this with present conditions, with a United States production of 63,000 metric tons, a world's production of 132,500 tons and a production cost that has been estimated as low as 10 cts. per lb.

G. A. Roush

It is interesting to note that the coal production in the United States to-day is equal to the world's production as reported in 1892. The United States was then second in production with Great Britain leading, while the United States now leads with a production almost equal to the combined production of her two nearest competitors, Great Britain and Germany. These two for several years past have ranked very close together, with Great Britain slightly in the lead, while 25 years ago Great Britain's production was double that of Germany. Although these three great producers have changed order in the tables and have all seen enormous increases of production of from nearly 100 to over 300 per cent in the course of 25 years, the production of all three still bears almost exactly the same ratio to the world's production, namely, slightly over 80 per cent of the total.

During the period under review the world's copper production has more than trebled, while the production of the United States has increased to six times its former amount. The United States has always led in production, but during that time has increased from 45 per cent to almost 65 per cent of the total. Twenty-five years ago Spain and Portugal came second, Chile third, Japan fourth and Germany fifth; the order now stands Japan second, Chile third, Mexico fourth, Canada fifth.

With gold and silver the figures are no less interesting. The gold production of the world has quadrupled while that of the United States has trebled. Twenty-five years ago the order of production was United States, Australia, Russia, Africa. At present it is Africa, United States, Australia, Russia. The African production, due to the enormous developments on the Rand, has increased to over 14 times its previous value, and now leads with about double the production of the United States, its nearest competitor.

The silver, up to 1911, had increased about 60 per cent, but in the last five years there has been a rapid decline, due to the revolutionary activities in Mexico, the heaviest producer, so that at present the production stands only about 10 per cent higher than 25 years ago. Since the price has dropped faster than the production increased, the world's production of silver in 1915 was worth only about one-half as much as the production of 25 years ago. The rise of prices during the

*The material of this article has been taken by permission from advance sheets of Mineral Industry during 1916.

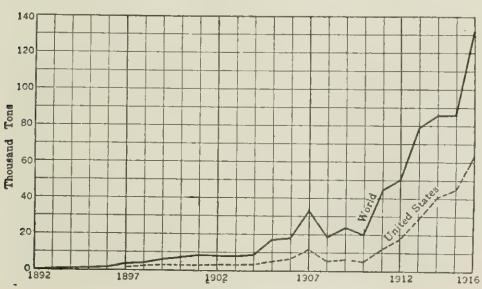


FIG. 1—ALUMINIUM PRODUCTION

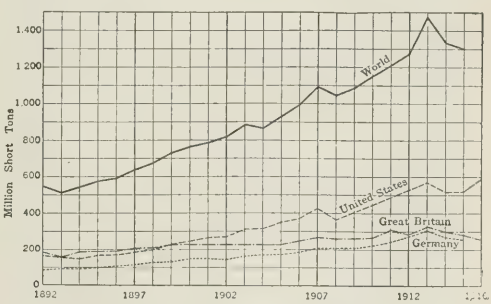


FIG. 2—COAL PRODUCTION

last year will, however, partly eliminate this discrepancy in value, and will reduce the deficiency in value from 50 to about 35 per cent. The United States started with a lead of 50 per cent over Mexico, the holder of second place, and ended with a production about double that of Mexico; but from 1902 to 1912 the Mexican production considerably exceeded that of the United States. The latter has shown an increase of about one-eighth, while Mexico has suffered such a decline as not only to wipe out the heavy lead with which she had held first place for 10 years, but has even pulled her considerably below her production of 25 years ago. Formerly Bolivia held third place, and Australia fourth. Mexico's position in second place is now being threatened by Canada, which formerly was far down the list, while Peru holds fourth place, and Australia has dropped behind Japan and Spain.

The production of iron ore in the United States now is about four times the production of a quarter of a century ago, and the pig-iron production has increased

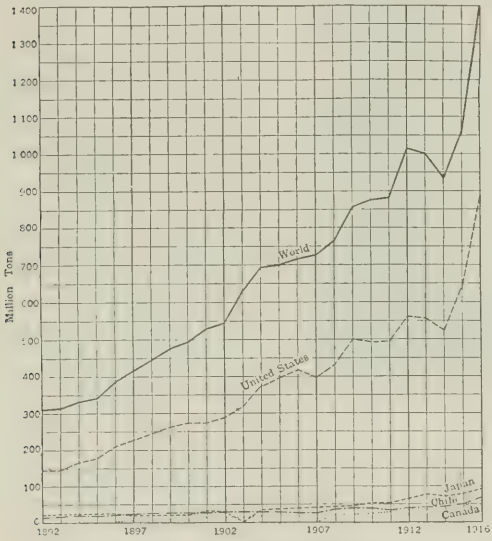


FIG. 3—COPPER PRODUCTION

in about the same ratio, while the pig-iron production of the world has increased to about three times its former amount. The order of producers is now United States, Germany, Great Britain, France, and Russia, with Austria-Hungary and Belgium practically tied for last place in the list of producers of more than 1,000,000 tons per year. The previous ranking was United States, Great Britain, Germany, France, Austria-Hungary, Russia and Belgium, with the last three all below the million-ton mark. Pig-iron production in the United States to-day is at a rate approximately a third greater than that for the entire world 25 years ago. It is true that the United States was in the lead in production then, but Great Britain was a close second, and the German production was over 50 per cent of the United States production. To-day the United States production is approximately 50 per cent of the world's production, or, in other words, is equal to that of all the rest of the world put together.

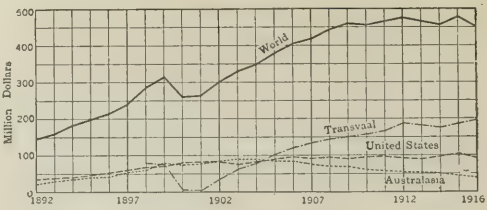


FIG. 4—GOLD PRODUCTION

The steel production naturally follows closely the production of pig-iron, and the order of production for the various countries is the same for steel as for pig iron, both at the beginning and end of the period under review. Due, however, to the development of processes which permit the use of greater proportions of scrap and waste material in the manufacture of the steel, and to the development of processes with higher percentage yields of finished steel on the raw material used, the total production of steel has grown faster than that of pig iron, and is now over five times what it was 25 years ago. And where the United States produced only a little over one-fourth of the former total, it now produces half, and the production of the United States has increased eight-fold.

During this period the processes used in the manufacture of steel have undergone a remarkable transformation. In 1892 almost 84 per cent of the steel production of the United States was made in the Bessemer converter, and 14 per cent in the open-hearth furnace. The corresponding proportions to-day are 26 per cent in the converter and 74 per cent in the open-hearth.

Lead production in the world during the past 25 years has approximately doubled. The ranking of producers at present is: United States, Spain, Germany, Australia and Mexico, all normally producing over 100,000 tons annually, but this figure has not been reached in Mexico during the last few years on account of the curtailment of production due to revolutionary activities. The former order of producers was the same as at present, except that Mexico was ahead of Australia. The heaviest increase was in the United States, amounting to about 260 per cent.

The enormous developments in the steel industry have demanded a proportionate increase in manganese production. The world's production is now about seven or eight times what it was 25 years ago, and there are

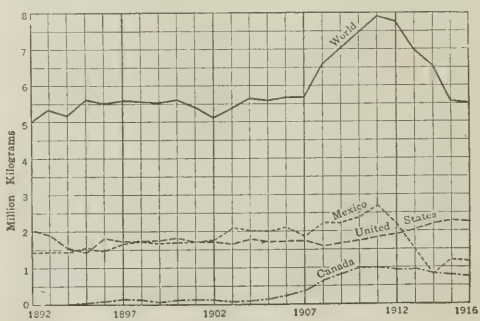


FIG. 5—SILVER PRODUCTION

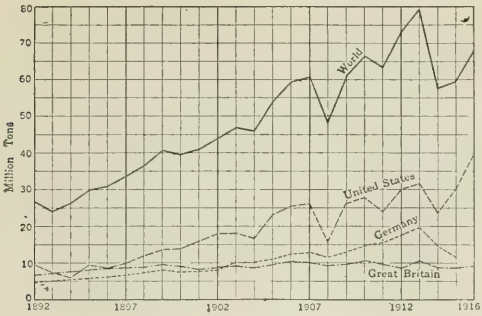


FIG. 6—PIG-IRON PRODUCTION

now three countries, India, Russia and the United States, with productions ranging from two to three times the world's production of 25 years ago.

The petroleum production of the world during the period has increased five-fold. In 1892 the producers showing more than 1,000,000 bbl. per year were the United States and Russia, together accounting for 97 per cent of the world's production. The present producers of more than 1,000,000 bbl. per year are, in order of production, United States, Russia, Mexico, Dutch East Indies, Roumania, Galicia, India, Peru and Japan. The United States now contributes 64 per cent of the world's production, as against 57 per cent 25 years ago, and now stands at about six times its former production. The Dutch East Indies, Peru, Argentina, Trinidad, Mexico and Egypt have entered the field as large producers during the period and now account for one-eighth of the total production.

The world's sulphur production is obtained almost entirely from Italy and the United States, with smaller amounts from Japan and Spain. Twenty-five years ago Italy was the producer of over 90 per cent of the world's supply, with most of the remainder coming from Japan. Consumption was on the increase, and the Italian production grew rapidly, reaching a maximum in 1905, when the production was nearly double that of 1892. Production in quantity in the United States began in 1903 and this soon reacted on the Italian production, which declined to about 50 per cent of the total.

Sulphur production during the 25 years has doubled, but pyrite production has more than trebled. Formerly France led in production, followed by Portugal, Germany, United States and Spain, all producing over 100,000 tons annually. The producers of that quantity

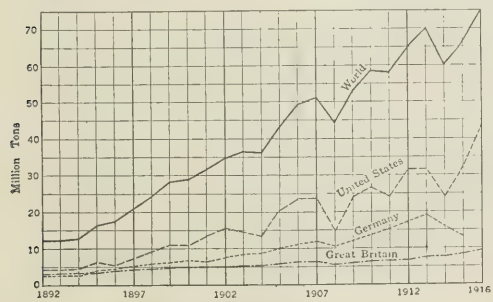


FIG. 7—STEEL PRODUCTION

at present are as follows: Spain, Norway, Portugal, United States, Italy, France, Germany, Canada, Russia, Japan and Hungary. Of all, Spain has shown the greatest increase, with Norway second. The Spanish production has jumped from 10 per cent of the total to nearly 25 per cent, and the Norwegian from 6 per cent to double that proportion. The United States production has just about kept pace with the total production.

The tin production of the world has, in the quarter of a century, almost doubled. Malaya still contributes a large share of the total, but has dropped from over 50 per cent almost to 40 per cent. England long held second place, but now Bolivia takes it with almost 20 per cent of the total, where formerly she was at the end of the list with 3 per cent. Banka still retains third place, having increased somewhat more rapidly than the totals. Australia and Billiton have both declined, the former the more seriously.

Tungsten is a metal that has seen almost its entire commercial growth within the period under review, and most of that within the last few years. The production of tungsten ores in this time has increased in a ratio of almost 50 to 1, two-thirds of which has been within the last five years. In the present production the United States accounts for 35 per cent of the total, Burma 22 per cent, Portugal 8 per cent, Australia 7 per cent, and Japan 6 per cent, all producing over 1000 tons annually.

Zinc production in the past 25 years has about trebled. Most of the leading zinc producing countries have been disturbed by the war to such an extent that recent figures are not available for comparison, but from the latest data available the United States was

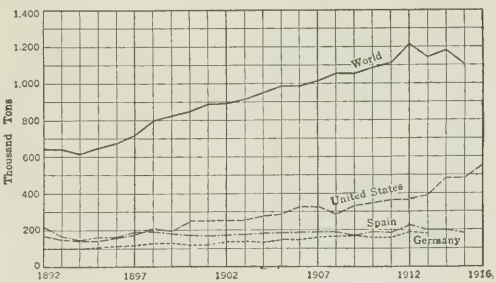


FIG. 8—LEAD PRODUCTION

the leading producer with Germany second, Belgium third, France fourth and Great Britain fifth. The former order was Germany, Belgium, United States, Great Britain, France. The United States has increased its production to eight times its former amount, and has increased its proportion of the world's output from 20 per cent to about 60 per cent.

It is of course absolutely impossible to make anything like a direct comparison between conditions now and twenty-five years ago, because now everything is on an abnormal basis. Some industries are swelled to beyond all semblance of their normal proportions by the extraordinary demands of war, while others are severely handicapped because of the disturbance of raw materials and markets, and the serious difficulties encountered in shipping, difficulties which are not by any means confined to trade with belligerent countries, but

extend also to the neutral countries and, in a large measure, to purely domestic shipping as well. However, in spite of all of the necessary readjustments, the period of the war has been, to most of the mineral and metallurgical industries, one of unparalleled prosperity. This is particularly true with aluminium, copper, iron and steel, tungsten, and zinc, which on this account have come to be classed under the heading of "war metals."

FUTURE DEVELOPMENTS AND INTERNATIONAL RELATIONS

What is in store for the future is difficult to foresee, but whatever may be the eventual outcome of the present conflict, it seems certain that the mineral and metallurgical industries will be called on to continue production to their utmost capacities in the work of restoration, and this will extend over a period of several years. It is to be expected that there will be somewhat of a slackening in speed after the conclusion of the war, for, however pressing may be her needs, Peace can never be the exacting taskmaster that War is; this slackening will be simply a logical outcome of the conditions, but it should not be of such proportions as to cause a serious slump in any industry as soon as the war demands are satisfied. On the contrary, manufacturing plants will be able to relax from the strain of war production and settle down to the fulfillment of the demands of peace and reconstruction at practically their normal capacity at the time. Of course it is not going to be possible after the war to keep the production curves of the various materials rising at the precipitous angle they have assumed during the war, for demand in many lines now is far above normal and is still increasing, but the normal course of the world's progress will soon bring it to a point where it can absorb these enormous productions, and it is quite possible that the demands of reconstruction will absorb the excess over a sufficient period of time to permit this condition to be realized, so that at the worst all the industries will suffer will be a period of a few years with little or no increase beyond the point at which they were at the close of the war, rather than a serious break in production and values.

The titanic forces of the present struggle are rapidly bringing to a head many conditions that normally would have required years of slow development. New industries are born over night and grow to a real semblance of maturity in weeks instead of years. Plant productions increase by leaps and bounds, doubling and trebling within the year under the impetus of an all-absorbing demand and an unprecedented price. New machinery and processes are developed and invention is stimulated in all branches of industry.

Since the opening of the European war the latter part of July, 1914, with its accompanying commercial

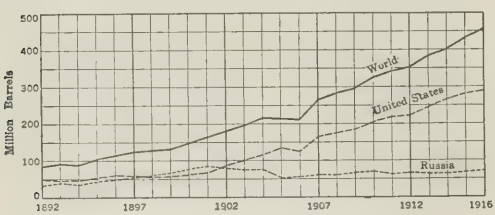


FIG. 9—PETROLEUM PRODUCTION

FIG. 10—SULPHUR PRODUCTION

disturbances, there has been a great deal of discussion in this country concerning the possibility of making the United States independent of foreign supplies in order to avoid future difficulties of this kind. This, of course, does not mean that all imports are to be discontinued, but that attempts be made to furnish domestic supplies of basic materials, in order that a whole industry may not be handicapped by the lack of some one material on which the process of manufacture depends. On analysis, however, this proposition does not prove to be as simple as it seems on the surface, particularly with regard to the mineral industry, either for the United States or for any other country. And, naturally, the smaller the country concerned and the more limited her resources, the more remote does any such possibility become. The discussion as here outlined is from the particular standpoint of the United States, but the arguments apply equally well, in a general way, to any of the other large mineral producing countries.

It follows from the natural course of human life and its needs that certain industries should be fundamental, and others secondary—or, in other words, that certain basic industries are concerned with the supplying of the prime necessities of life in their crudest forms, while the other industries are concerned with the modification of these crude forms through various stages of higher refinement, or with modifications of form, location, etc. Of these basic industries, probably none is more widely scattered over the face of the earth, more closely related to the general welfare and progress of the countries concerned and, in fact, more thoroughly universal than the mineral industry, with the

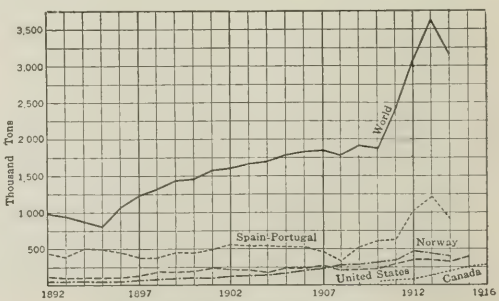


FIG. 11—PYRITE PRODUCTION

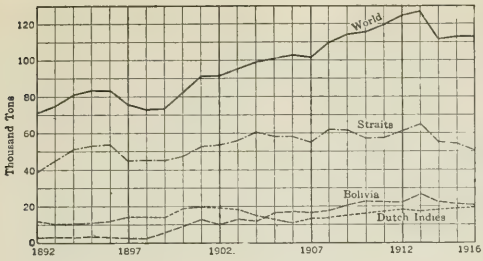


FIG. 12—TIN PRODUCTION

single exception of agriculture. In no other industry is the influence of a single locality so widely felt as in the mineral industry. For years the world went to Ceylon for its graphite, to Sicily for its sulphur, to the Ural Mountains for its platinum. A small district in the State of Arkansas furnishes the raw material for 65 per cent of the world's supply of aluminium. Chile furnishes practically the entire world's supply of sodium nitrate and Germany has supplied such a large proportion of the world's supply of potash, that the limitations of production and exportation resulting from the disturbances of war have made a shortage of this most necessary material throughout almost the entire world. And carrying things to the opposite extreme, it requires almost a page to list the countries that produce important quantities of the ores of gold, silver, copper or iron.

Probably every country and every state on the face of the globe has within its borders valuable mineral resources of one kind or another, of greater or less importance. In many cases it is something that is merely of local interest and importance; in other cases, such as those mentioned above, the materials are of international importance. Dana classes ice as a mineral, but its use purely as a mineral substance is probably limited to its employment as a building material in the arctic regions. Southern Indiana's Bedford limestone and Vermont's granite, however, while used for the same purpose, are naturally of incomparably wider application and value. When the production and use of any material is purely a matter of local interest, any knowledge or information concerning the industry involved in the production is also merely of local interest. But just as the breadth of the market and the scope of application of any material increases, so does the demand for information in regard to that material increase. The more general is the demand for the material itself, the more general is the demand for knowledge concerning the progress of the industries producing this same material in other localities, and on this demand for knowledge there can be placed no final limitation except one of degree. Other factors, geographical or political, economic or social, are contributive, rather than determinative.

The Arizona copper producer is interested more in the Montana production than in that of Utah, not because it comes from Montana, but because it is a heavier competitor in his market; but should the Utah production exceed that of Montana, Arizona's interest would follow the heavier producer, rather than remain in a given locality. Europe is interested in the Chilean copper developments, not because they are in Chile, but because they promise an additional amount of metal available for import into Europe, and the interest would be just as great if the deposits were in Fiji or Greenland.

As Kipling says, "The Colonel's lady and Julia O'Grady are sisters under skin." The laborer, the superintendent, the general manager, the New York capitalist, all have the same general interest, differing only in intensity and extent, depending on the contributing factors. The laborer makes his living from his work in the mines or smelter, and wants to know how things compare in the mine where he works and in the other mines in the neighborhood. The superintendent compares conditions in his own working district with the adjoining districts. The general manager in charge of plants in different parts of the country will consider matters on a still broader scope, and the capitalist will compare his holdings in this country with those in other countries. And so we have in every case, from whatever angle the question may be considered, an interest proportioned to the extent to which the individual is affected by the conditions within his own particular field of operations, as compared with other fields of similar work.

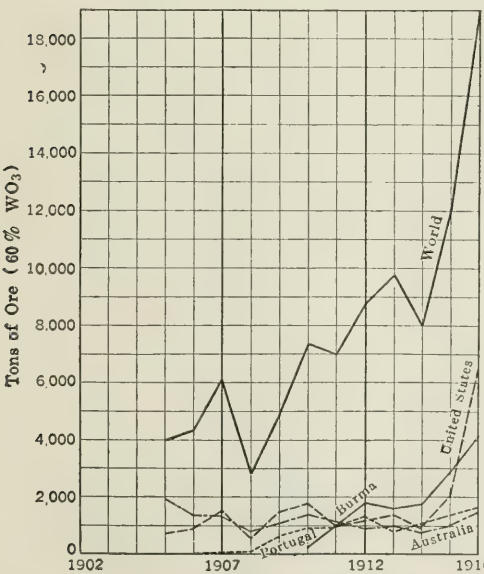


FIG. 13—TUNGSTEN PRODUCTION

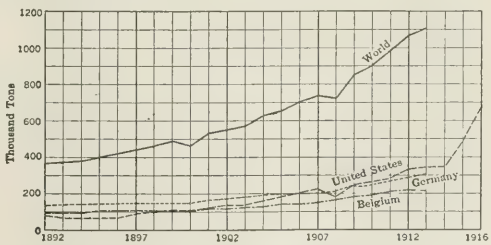


FIG. 14—ZINC PRODUCTION

The general interest thus manifested and the demand thus created for knowledge of the progress of an industry in different localities is inseparably linked with the economic dependence of each country of the world on most of the other countries. That stage of civilization when the world was made up of a number of independent districts is long past. A given locality can no longer produce within its own confines everything that is demanded in the course of its life. In the first place, civilization has reached a point where it demands more than it has in the past, and in the second place, economic development and the law of the survival of the fittest has led to an age of constantly increasing specialization, which, aided by increasing ease of communication and transportation, has brought things to a point where we now find ourselves dependent for one thing or another on almost every district of the civilized world.

This dependence can be well illustrated as the average man looks around his own home. He no longer lives in a house of his own building, eats food of his own growing, cooked in vessels of his own making, and wears clothes of his own weaving. In the average man's house we now see aluminium which probably originated in Arkansas, or possibly in France, and which, in the course of manufacture demanded cryolite from Greenland. He reads a newspaper printed from type containing lead from Missouri, Idaho, Utah or Mexico, and antimony from China. The asbestos pads on the stove came from Canada, and the polish on the stove from Korea, or possibly from Ceylon or Madagascar. The street in front of the house is paved with asphalt from Trinidad. The house is painted with barium from Germany. He frequently uses as a medicine iodine from Chile and bismuth from Bolivia. Such steel as he uses comes mostly from the United States, but the furnace in which it was made required magnesite from Austria or Greece, and as the steel came from the furnace it was deoxidized with manganese from Russia, India or Brazil. To make his stove bright and cheerful it is given windows which are glazed with mica from Canada or India. He gets his light at night from gas mantles made from monazite from Brazil or from electric globes, the tungsten filaments of which may have originated in the United States, but which are just as likely to have come from Burma or Bolivia. He uses nickel from Canada and tin from Bolivia or Malaya. He fertilizes his lawn and garden with nitrate from Chile and potash from Germany. His wife cherishes an engagement ring bearing a tiny diamond from South Africa, set in platinum from Russia, and dreams of some time having a necklace of "real pearls" from the South Sea Islands. They eat off china from Germany, with silverware that might have come from almost anywhere, and after dinner he smokes a cigar that he fondly thinks came from Havana.

So close is this association of the various countries in a commercial way, that any factor that disturbs one country will disturb several, through its commercial relations with the others, and anything that disturbs several will disturb practically all. An indication of this condition is the unanimity with which the contributors to the technical press mention the effects of the present European war on the various industries that they happen to be discussing. Almost without exception, these industries have been considerably affected by the war. Some have been stimulated and some have been retarded and disorganized, but very few have remained unaffected.

These two factors, the individual interest in other localities supporting a given industry, and the interdependence of the various countries on each other for adequate supplies of certain materials, make necessary the dissemination of general information in regard to the status of the various industries from time to time. There are in the various states and countries certain organized agencies for the collection and distribution of such information, and the technical press gives a large amount of general information along these lines. But there is still room for considerable expansion along this line. Information should be fuller and more detailed, and should be made available more promptly.

It is not to be expected with the present broad development of all the various industries that any country of importance can become entirely independent of others in the matter of mineral production. It is possible to become partly so by the fullest development of the domestic resources, but absolute independence is impossible, because no one country, not even the United States nor Great Britain, with all her colonial possessions, includes within its boundaries *all* of the almost infinite varieties of mineral products that are now demanded by our every-day life.

PERSONAL CO-OPERATION

The prime requirement for the best development of domestic resources is a thorough knowledge of those resources. And for the best results, this knowledge must be well disseminated and not be confined to a few people in the immediate locality. In other words, every available source of material should be thoroughly advertised—not necessarily by paid advertising—but by proper publicity in the technical press, in order that the information may be readily available to all who are interested. This condition is at present only partly fulfilled, and there is room for considerable improvement.

And next in importance after a thorough knowledge of domestic conditions, is an equally thorough knowledge concerning the various foreign sources of any given material. This is, of course, more difficult to secure, and information is not nearly so plentiful as for domestic conditions and usually the more remote the locality the more meager is the information. Many of the disturbances of the past three years in foreign supplies of materials would doubtless have been considerably lessened if importers had had a fuller knowledge of sources of materials. Too many had no information beyond their own particular source of supply. And in many cases the necessary information was very hard to secure.

All the evidence, then, points to the necessity of fuller information concerning both foreign and domestic supplies of materials. And since it seems impossible for any country to be minerally independent, let each at least exert a reasonable degree of care in the apportionment of its dependence, for the strain can be considerably lessened for all by a proper exchange of information. To this end, co-operation between the various agencies interested in the collection and dissemination of such information is to be encouraged and fostered to the utmost possible degree.

An Experiment in Scrubbing Carburetted Water Gas for Recovering Aromatics*

Robert J. Moore and Gustav Egloff

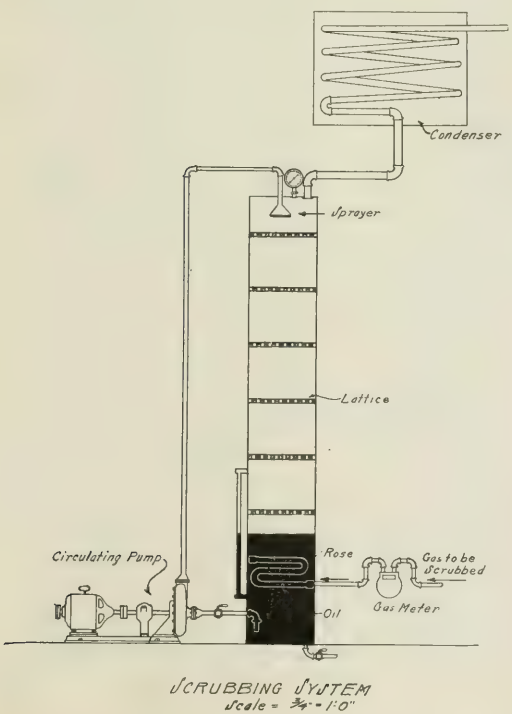
Considerable prominence has recently been given to the discussion of scrubbing carburetted water gas with a view to combating the shortage of toluene and benzene. The report, dated July 20, of Dr. W. H. Nichols, chairman of the Committee on Chemicals of the Council of National Defense, emphasizes the toluene shortage, and says that "efforts are going to be made immediately to increase this supply by 'stripping' the gas in large cities." In view of these facts the writers are of the opinion that the following experiment in scrubbing a representative water gas will be of interest to the oil fraternity.

EXPERIMENTAL

The carburetted water gas fresh from superheater was measured by passing through a dry meter and thence into an 18-in. diameter pipe 10 ft. in height (see diagram). In this pipe 25 gal. of technical paraffin "straw" oil was utilized for the scrubbing of the gas, which passed below the surface of the oil through a rose. As the gas passed through, the oil was circulated by means of a pump and sprayed over a series of lattice woodwork set within the pipe by means of supports. This circulation and spraying of the scrubbing oil facilitated the solution of the light oil molecules in the gas. Above the scrubber a condenser coil and box was placed so as to minimize the scrubbing oil losses.

Twenty-five gallons of straw oil were used in a charge. When 1000 cu. ft. of gas had passed through the system, the benzolized oil was transferred to a one-barrel still (42 gal. capacity), with adequate steam and condensing arrangements. This oil was steam and gentle direct-fire distilled until a temperature of 175 deg. to 180 deg. C. was reached in the oil vapor line. At this temperature practically all of the light oil distilled off. This fact was carefully checked by analysis of the original straw oil and the debenzolized straw oil as shown in the following tables.

*Presented at the fifty-fifth meeting of the American Chemical Society, Boston, Sept. 11-13, 1917.



SCRUBBING SYSTEM
Scale = 3/4" = 1'0"

TABLE 1
ANALYSIS OF ORIGINAL STRAW OIL
Distillations in standard Engler 100 c.c. flask at rate of 2 drops per second
Specific gravity 0.848/15.5 deg. C.

Temperature, Deg. C.	Per Cent by Volume	Specific Gravity 15.5 Deg. C.
310	1st drop	....
310 to 325	6.1	0.829
325 to 350	60.4	0.845
350 to 375	21.5	0.852
375 to 392	8.0	0.854
392 cracking	....	....

TABLE 2
ANALYSIS OF OIL AFTER STEAM DISTILLATION
Specific gravity 0.628/15.5 Deg. C.

Temperature, Deg. C.	Per Cent by Volume	Specific Gravity 15.5 Deg. C.
306	1st drop	....
306 to 325	9.7	0.833
325 to 350	55.0	0.844
350 to 375	18.7	0.851
375 to 389	10.0	0.855
389 cracking	....	....

Comparing tables 1 and 2 no greater variation is found than one usually finds in oil distillation by the Engler method, showing that all the light oil present after the scrubbing was removed by the steam and direct-fire distillation. Some loss of the straw oil occurred in operation, but all the light oil was recovered, as far as practicable, the conditions of the experiment approximating plant conditions.

LIGHT OIL RECOVERED

The light oil recovered was 1.211 liters per 1000 cu. ft. of carburetted water gas washed. This oil was yellow and had the characteristic odor of a cracked oil. Its unsaturated content was high, 35 per cent combining with 1.84 specific gravity sulphuric acid. Due to this high percentage it was necessary to control the velocity of sulphonation by cooling to zero degrees due to the considerable heat generated by the interaction in order to avoid loss of aromatics, either by evaporation or by combination at higher temperatures. The analysis of the light oil is given in table 3.

TABLE 3.
DISTILLATION ANALYSIS OF LIGHT OIL.
Specific gravity 0.868/15.5 deg. C.

Temperature, Deg. C	Per Cent by Volume	Specific Gravity
39	1st drop	....
39 to 75	3.8	....
75 to 100	55.2	0.867
100 to 125	24.9	0.869
125 to 150	5.9	0.868
150 to 175	1.0	....
175 to 200	0.8	....
200 to 225	1.1	....
225 to 250	0.1	....
250 to 300	0.7	....
300 to 325	1.4	....
325 to 350	4.0	0.831
Residue	1.0	....
Loss	0.5	....

In the above table the 6 to 7 per cent distilling at the higher temperatures is probably due to straw oil carried over during steam distillation.

The per cent by volume of the benzene, toluene and xylene cuts from the light oil are given below in table 4, together with the gravities and also the amounts of unsaturateds in each cut.

TABLE 4.
PERCENTAGE OF BENZENE, TOLUENE AND XYLENE CUTS AND UNSATURATEDS IN THESE CUTS.

Cut, Deg. C.	Per Cent by Volume	Specific Gravity	Per Cent of Unsaturated
Benzene (to 95)	51.8	0.866	46.0
Toluene (95 to 120)	24.1	0.869	18.0
Xylene (120 to 150)	6.0	0.868	24.0

This high per cent of olefins (table 4) formed in carburetted water gas as manufactured in the standard plants to-day would naturally be a retarding influence on the success of the scrubbing process, involving as it does a complicated low-temperature washing system and purifying of the aromatics with the losses attendant thereto. Therefore it may be feasible to adopt certain modifications in the water gas works with a view to decreasing the percentage of olefins formed. There has been much research along these lines, but little actual installation. The method of admixing to the blue water gas, hydrogen gas in order to decrease unsaturation has been shown by Whitaker and Leslie[1] to be of little use so far as the above problem is concerned, since their work indicates that low molecular weight olefins are not hydrogenated to any extent. Whitaker and Rittman[2] show the results of gas making under increased and decreased pressure, while Egloff and Twomey[3] find that cracking a gas oil at higher temperatures than usual effects a decrease in the per cent of olefins and increases the aromatic formation. It seems to the authors that in view of the necessity of obtaining toluene and benzene in larger quantities than now possible certain changes may be advisedly made in the water-gas machine involving either temperature, pressure or admixed gases so as to increase the yield of the above-mentioned by-products. Carrying out the preparation of the blue water gas independently of the cracking of the oil in the carburettor and mixing these products later may be a solution of the problem. Since the carburetor then is in a separate system, either increased or decreased pressure may be used in cracking as desired. Such changes may be feasible in view of the propaganda to change the gas standard from an illuminating basis to a heat unit. Or the benzene fraction with its high olefin content may be returned to the gas depriving the latter of only its toluene and xylene.

YIELDS OF AROMATICS FROM THE LIGHT OIL

To determine the percentage yields of benzene, toluene and xylene actually obtainable from the light oil obtained by scrubbing, 1 liter was carefully treated with sulphuric acid, neutralized with sodium hydroxide, washed with water and dried over fused calcium chloride. This dried oil was distilled in an efficient fractionating column and analyzed by a method already described.[4] The results were as follows:

	Per Cent by Volume
Benzene	22.1
Toluene	20.0
Xylene	5.1

THE VOLUME OF AROMATICS RECOVERABLE FROM 1000 CU. FT. OF GAS

Since the volume of light oil recovered from 1000 cu. ft. of carburetted water gas was 1.211 liters, or 0.032 gal., and the percentages of benzene, toluene and xylene are as given above, the volumes of these aromatics per 1000 cu. ft. of gas are as given below in table 5.

TABLE 5.
BENZENE, TOLUENE AND XYLENE RECOVERABLE FROM 1000 CU. FT. GAS

	Liters	Gallons
Benzene	0.267	0.0707
Toluene	0.242	0.0640
Xylene	0.062	0.0163

In view of the fact that the annual production of carburetted water gas is in the neighborhood of 150 billion cubic feet the above figures are significant.

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Columbia University, New York City.

[1] J. Ind. Eng. Chem., vol. 8, 1916, 593.
[2] J. Ind. Eng. Chem., 1914, 6, 383.
[3] Met. Chem. Eng., XIV., 247, 1916.
[4] Egloff and Twomey, Met. & Chem. Eng., 14, 247, 1916.

The Resilience Test

By Henry M. Howe

A given specimen of steel, though ductile under common static tensile test, may be extremely brittle under the impact test of the Fremont type, Fig. 1, in which a nicked test piece, *A*, lying level and supported at both ends, is struck a sharp blow in the middle of its length by a falling ram, *B*.

It is certainly disquieting to learn that a form of brittleness exists which our present reception test, the static tensile test, cannot detect. It is of course possible that this form of brittleness cannot lead to failure under service conditions, but this is certainly far from self-evident. Indeed, the natural presumption is that it may lead to failure, and that, in not attempting to detect it, we put ourselves in the position of the cashier who, though knowing that the market is flooded with detectable counterfeits, takes no efficient steps to detect them, but accepts all deposits at their face value.

I believe that the present evidence goes far to prove that the static tensile test does not and cannot determine the fitness of material for resisting shock when in pieces which are threaded, nicked, or of equivalent abrupt change of section, and hence that for such services this test should be supplemented by an impact test.

When we reach this point, we find ourselves confronted with a very difficult choice between various tests, carried out under radically different conditions.

Before taking these up let us agree on our terms. Here are those which I propose:

Resilience is now used as the measure of the work done in breaking the test piece by a shock test. It is the product of the average resistance to deformation up to rupture into the deformation before rupture, and thus it corresponds in a sense to the product of the tensile strength into the elongation of the static tensile test. It is measured in kilogram-meters (kg-m.). It is perhaps more usefully regarded as the measure of the ability to resist shock, or *"shock resistance."* As the static tensile test tells whether a test piece is statically strong or weak, so the impact test tells whether it is *resilient* or *irresilient*. Impact-resistance is more accurate than resilience.

Beyond this, the impact test tells us the degree of deformation before rupture under shock. This we may call the *"shock ductility,"* corresponding to the elongation and the contraction area of the static test, which we group together as "ductility."

Thus, both file steel and rivet steel are irresilient, for the file steel offers great resistance to each unit of deformation, it breaks before deforming greatly, and though rivet steel deforms greatly, it offers but little resistance to the unit of deformation because of its low elastic limit.

Turning now to the methods of test, the resilience, or work done in rupture, is determined by subtracting

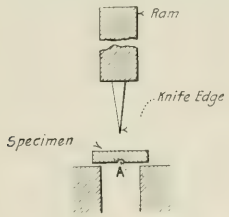

FIG. 1—THE FREMONT NICKED BENDING IMPACT TEST

from the total energy of the blow the residual energy left after breaking the test piece.

Two prominent types of testing machine need attention, those with a vertically falling ram of the Fremont type, Fig. 1, in which the residual energy is measured by a spring against which the ram strikes after breaking the test piece, and those with a swinging pendulum, the impact of which breaks the test piece, Fig. 2. The pendulum then swings on past the fragments of the test piece, and the height to which it now rises is the measure of the energy residual after causing rupture.

Instead of being broken by bending, as in Fig. 1, the test piece may be broken tensilely, by setting its length parallel to the path of the falling ram or tangentially to that of the pendulum.

Finally, the test piece may be either notched or plain, or, as I have suggested lately, threaded throughout its reduced section.

To the Fremont or vertically falling ram type it is objected that the mechanism for measuring the residual energy is untrustworthy, whereas the pendulum type has no corresponding defect, because the height to which the pendulum rises after passing the test piece is not subject to error or to misreading. The objection to the Fremont type is supported by an enormous mass of evidence showing extreme irregularity of results, though in some cases the concordance has been good. Its advocates explain that this represents heterogeneousness of the material tested, an important concession to which I shall return. The validity of this explanation can be tested readily, one believes, by testing the machine in blank, dropping its ram repeatedly from various heights, and noting whether for given height the energy indicated by the dial is constant.

To the bending type of test piece it is objected that this determines primarily the properties of the test piece at one spot only, the outer fiber immediately opposite the point of impact, because the properties of the metal at this spot have a wholly disproportionate influence on the apparent resilience of the piece and on the angle bent. A heterogeneous metal would appear resilient or irresilient, ductile or brittle, according to whether this part of this outer fiber happened to lie in a strong or a weak part of the bar, for instance to include or to escape a local flaw.

To nicking a like objection is made, whether for tensile or bending tests, that the properties of the material in the nicked section have a disproportionate influence in determining the resilience and ductility.

This objection applies with double force to the nicked bending test, for whereas in the nicked tensile test the whole of the cross section at the nick resists the stress relatively uniformly, in the nicked bending test it is solely the material at the apex of the nick, *A* of Fig. 1, that has this disproportionate influence in determining the resistance to rupture. We of course wish to learn the properties of the material at its weakest part. For a piece to be used in tension we wish to know the properties of the weakest section. Hence in our test it is the properties of the weakest section that we seek. Clearly, in a heterogeneous material the chance that the weakest place will happen to lie just at the apex of the nick of a bending test piece is less than that in a nicked tensile piece it will happen to lie somewhere in the nicked section.

Unfortunately, there is much to indicate that the nick is a necessity in testing materials for service in which the object itself is nicked, for instance those in which there is a screw thread. Direct comparative tests tend to show that certain material which has fair resilience when unnicked is very fragile when nicked, and that nicking may reverse the order of fragility of two materials. If this is true, if nicked fragility cannot be inferred from the results of an unnicked test, then I do not see how nicking can be avoided for nicked services.

But there is a special form of nicking which is not open to the objection that it localizes the application of the test, so that it is likely to escape the weaker parts of heterogeneous material, and this is to thread the

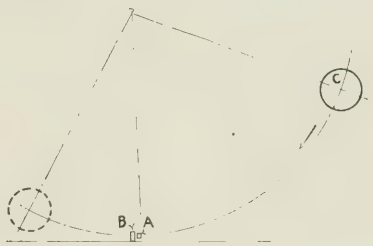

FIG. 2—THE CHARPY PENDULUM FOR IMPACT TESTING.
A—The test piece for the bending test.
B—The support.
C—The pendulum.

whole of the reduced section with a sharp spiral thread. With such a thread, rupture should occur at the weakest section in the reduced part of the test piece. The merit of such a suggestion can be learned only by thorough trial.

The nicked bending test is said to be much cheaper to make than any other.

The objection to the bending test and to nicked tests in general—that they are likely to miss flaws, defects, and local weaknesses due to segregation or to foreign bodies or sonims—evidently decreases in force when applied to material known to be extremely homogeneous. For instance, it may prove that the objection should be

waived in the case of crucible steel and of electric steel cast in ingots as small as those usual in the crucible process. Again, it may prove that etching tests may establish the homogeneousness of the material so fully as to justify waiving these objections in view of the cheapness and convenience of the nicked bending test. In that case, material which is shown by etching to be heterogeneous might have to pass a special threaded impact tensile test, while for that shown to be homogeneous the nicked bending test could be used.

Before we can put ourselves in a rational position by adopting a resilience test so as to detect and reject irresilient material for impact services, we need much more light on questions such as those which I have raised, as to the relative merits and the applicability of the several methods of test.

Here two questions seem of extreme importance. First, is there any one form of impact test which will measure the resilience for both nicked and unnicked services, for objects with a screw thread or its equivalent sharp change of section, and for plain objects which lack these changes? On the general principle that the conditions of the test should reproduce the most trying conditions of service, a nicked test is certainly indicated for nicked services. Yet for unnicked service a nicked test seems inappropriate, calling upon the material to possess a quality—ability to resist impact when nicked—which will never be utilized in service and hence is not needed. To provide it is to tax the user and through him the public needlessly. Hence we should learn whether the degree of unnicked resilience can be safely inferred from a nicked impact test. A possible way of answering this question is to apply the nicked test to unnicked objects which, in service, have a relatively small factor of safety and occasionally break; for instance, railroad axles and those parts of motor cars which fail most often. Collect a large number of such objects of which some have failed quickly while others have shown great endurance, and others still have endured only tolerably well. Determine whether a nicked test gives a fair measure of their relative merit.

Conversely, determine how fair a measure of their merit is given by an unnicked test.

Proceeding on the same principle, determine whether a nicked test is really needed for nicked services, or whether the indications of an unnicked test can be trusted. An examination of the existing evidence may well show that for nicked service a nicked test is indispensable. If it does not answer this question fully, then an answer could be had by applying an unnicked test, parallel to that which has just been outlined, to objects some of which, in nicked service, have shown themselves excellent, some bad, and some tolerable.

The second of the important questions concerns the trustworthiness of nicked tests in general. If the investigations already outlined should show that only by a nicked test can fitness for nicked service be determined, then we should have to consider whether the results of test with a single nick are trustworthy, and, if not, whether the test piece should be threaded and tested tensilely. If the great irregularity of the Fremont results, which is certainly very far in excess of the irregularity of static tensile tests on like materials, is traced to defects in his method of measuring the resilience, we should turn to the pendulum machine and determine the concordance of the results to be had with it, both with nicked bending and with nicked tensile impact test pieces. If neither of these gave concordant results, we should consider the relative merits of the tensile impact test on test pieces threaded instead of being nicked, and of arriving at a trustworthy result by manifolding the single-nick tests, and thus getting a number of results large enough to form trustworthy evidence of fitness, the smallest and not the mean resilience being taken as the true measure.

To perfect and carry out the details of such a program would imply so much work that it might well be undertaken by a commission. To our great consumers, such as the railroads and the makers of motor cars and of electrical machinery, the need of a trustworthy measure of resilience, a trustworthy means of detecting fragility, is so great that they ought to be willing to co-operate in forming such a committee.

The chief questions to be answered may be summed up thus:

1. Can either the nicked or the unnicked test be made to give trustworthy results of fitness for both nicked and unnicked impact service?

2. With materials of such a degree of heterogeneousness as ought reasonably to be provided for, can a single-nicked test piece give a trustworthy measure of resilience?

3. If not, is it more expedient to substitute a two-inch threaded length of impact tensile test piece for the single nick, or to test of each material so large a number of test pieces as to insure detecting approximately the weakest section?

Zinc Furnace Temperatures—I

Data on Different Kinds of Ores and Furnaces

By Edward Mackay Johnson
Superintendent Eagle Picher Lead Co.

NATURAL GAS FURNACE, COMMON RETORTS

The following temperature data were obtained by the writer on a natural gas furnace with common retorts. They indicate the temperature in the open retort as indicated by Norton cones.

The cones were placed at the back end of the retort, in the middle row, near the middle part of the furnace. The time was recorded when the top of the cone bent over to the clay. The firemen were in no case requested to use the cones as a guide in firing, but merely record the time when the cones went down. It was found, however, that some of the men would take an interest in the cones and even use them as an additional guide in firing. This was especially true of new firemen "breaking in." The cones certainly act as a warning with respect to getting "butchers" as in some cases it was found safe to get No. 7 cone down, with other ores No. 8, and in exceptional cases start No. 9.

Table I represents the average of the daily records, and the writer feels that they are not very far from the temperatures existing in the open retort during the distillation period.

REGENERATIVE FURNACE, HYDRAULIC RETORTS

The temperatures in Table No. 2 were obtained with a regenerative type of furnace using hydraulic retorts. As before they indicate the temperature in the open retort as indicated by Norton cones. The cones were placed at the back of the retort in the bottom row

TABLE 1—CONE RECORDS FOR NATURAL GAS FURNACE, COMMON RETORTS

Furnace Number	Month	Time of Attaining Temperature of: Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.
Part 1. Charge. ½ Leadville Calamine + ½ Western Sulphide								
1	Aug....	5:00	7:00	9:00	11:00	1:00	2:30	
1	Sept....	4:30	6:30	8:30	11:00	12:40	2:00	
3	Aug	6:00	8:00	10:00	12:00			
3	Sept....	6:20	8:30	10:30	12:30	1:00		
2	June	5:25	7:15	9:25	11:40	12:25	2:00	
2	July....	6:30	8:30	10:00	11:30			
4	June....	5:15	7:20	9:30	11:40	1:35	2:40	
4	July....	7:20	9:30	10:30	12:00	1:30	3:00	
5	July....	6:00	8:00	10:30	12:00			
5	Aug.	5:00	7:30	9:20	11:00			
6	June....	4:30	6:20	9:15	10:15	12:20		
6	July....	5:30	7:40	10:00	11:40			
6	Sept	5:40	8:30	10:40	12:50			
Average	time	5:40	7:40	9:45	11:35	1:20	2:25	
Part 2. Charge: ⅔ Leadville Calamine + ⅓ Joplin								
2	Oct	4:00	6:00	8:00	10:00	12:00		
4	Oct	4:30	6:40	9:00	11:00	1:00	2:30	
5	Oct	4:00	7:00	9:30	11:30	12:10	2:10	
7	Oct	3:00	4:40	6:50	9:10	11:40	1:15	
Average	time....	3:50	6:05	8:20	10:25	12:15	2:00	
Part 3. Charge: ⅓ Leadville Calamine + ⅔ Joplin								
7	Aug	1:00	2:20	4:10	6:20	8:30	10:30	12:20
7	Sept	2:00	3:40	5:50	8:00	10:00	12:00	
9	Aug....	1:00	2:40	4:40	7:00	9:00	10:40	12:30
9	Sept	1:00	2:30	4:30	6:30	8:30	10:30	12:20
8	June....	1:20	3:15	5:30	10:30	12:15	2:30	
Average	time....	1:24	3:10	5:10	7:55	9:55	11:15	12:20
Part 4. Charge: All Joplin								
8	July....	1:25	3:00	4:30	7:10	8:30	12:30	
9	Oct.....	1:00	3:00	5:30	7:30	9:50	10:40	2:15
10	June.	1:30	3:20	6:15	9:20	10:25	1:30	2:20
10	July....	1:20	3:00	5:30	9:00	10:30	1:10	
Average time, Part 3 and 4....		1:20	3:05	5:25	8:15	10:00	12:25	2:17

Analysis of charge:

Leadville Calamine		Western Sulphide		Joplin	
Zn..	30%	Zn.....	50%	Zn...	54.6
Fe..	10	Fe.....	17	Fe. .	4.2
Mn	3	SiO_2..	2	SiO_2..	6.1
SiO_2.	12	Pb.....	2.4	Pb	0.76

TABLE 2 -CONE RECORDS FOR REGENERATIVE FURNACE, HYDRAULIC RETORTS

	Time When Temperature was Attained of: Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.	Cone 9 1310° C.
Part 1: Charge of Western Ore; Zn=53%, Fe=11%								
	1:07	3:00	5:50	8:15	9:40	11:30	2:30	
	1:08	2:40	4:10	7:15	9:45	12:20	3:00	
Average time	1:08	2:50	5:00	7:45	9:45	11:55	2:45	
Part 2: Charge of Roasted Joplin Ore, Zn=67%								
	12:15	1:45	3:40	5:35	7:45	10:20	12:50	
	1:00	1:50	3:45	5:50	8:00	10:35	1:40	3:20
Average time	12:40	1:50	3:45	5:40	7:55	10:30	1:15	3:20
Part 3: Charge of Silicote Ore, Low in Pb and Fe								
Average time.	1:10	2:30	4:15	5:50	7:25	8:40	10:30	12$20

All times represent the average reading for two months.

about the middle of the furnace. The time was noted when the cone had bent over to touch the clay.

From a comparison of Tables 1 and 2 it will be observed that there is considerable difference between them with respect to the Western ores, while upon the Joplin ore they agree more closely. This is mainly due to the fact that some metallurgists when treating Western ores bring the furnace along somewhat faster and work it off closer, while others bring the furnace up slowly, holding it a little greener in the morning, and thereby obtaining more metal at the third draw. If the recovery be the same in both cases the latter method is to be preferred, as it is easier on the retorts, the men, and the furnace.

COAL-FIELD FURNACE, HEGELER TYPE

The following is a log of furnace temperatures taken between the retorts in the laboratory of a coal-field furnace of the Hegeler type, with no regenerators; 1¼-in. slack coal was used, and the furnace operated on Joplin ore. Charging of the furnace was commenced at 5 a. m. and finished at 11 a. m. The draft in the furnace was from 2 in. to 2¾ in.; in the producer it varied from ½ in. just after coaling to 4 in. just before recoaling.

TABLE 3 –PYROMETER READINGS IN DEGREES C. IN HEGELER FURNACE

4th Sec., 3d Row		14th Sec., 3d Row		19th Sec., 3d Row		Remarks
Time	Temp.	Time	Temp.	Time	Temp.	
A.M.		A.M.		A.M.		
10:55	1060	10:58	900	11:00	815	
11:28	1070	11:32	920	11:35	860	Clinkered. Air pressure off 8 min.
11:55	1085	11:58	970	12:10	890	
P.M.		P.M.		P.M.		
1:03	1130	1:15	1085	1:18	1015	Clinkered. Air pressure off 7 min.
1:52	1140	1:56	1110	2:00	1040	Coaled up. Air pressure off 4 min.
2:46	1155	2:55	1125	2:58	1075	Clinkered. Air pressure off 7 min.
3:42	1165	3:47	1150	3:51	1090	Coaled up. Air pressure off 5 min.
4:58	1165	5:50	1160	5:09	1115	Clinkered. Air pressure off 8 min.
5:55	1210	5:59	1180	6:04	1110	Coaled up. Air pressure off 3 min.
6:55	1220	7:01	1210	7:06	1120	Clinkered. Air pressure off 9 min.
				7:09	1090	
				7:15	1080	
7:58	1200	8:05	1220			Coaling up. Air pressure off 5 min.
8:53	1230	8:59	1200	9:03	1140	
9:22	1230	9:26	1215	9:30	1165	Clinkering. Air pressure off 15 min.
				9:31	1155	During this clinkering and coaling up, the temp. dropped 60 in the blue powder.
				9:32	1130	
				9:33	1125	
				9:35	1110	
				9:42	1105	
				9:48	1140	
10:21	1240	10:26	1220	10:30	1165	
11:11	1265	11:16	1230	11:18	1190	Clinkering. Air pressure off 9 min. Temp. in blue powder dropped 55 deg.
				11:19	1170	
				11:20	1155	
				11:23	1140	
				11:25	1140	
				11:27	1135	
A.M.		A.M.		A.M.		
12:19	1265	12:25	1230	12:27	1190	
12:59	1275					Clinkered. Air pressure off 9 min. Temp. in the fronts dropped 20 deg.
1:00	1270					
1:01	1265					
1:03	1255					
1:04	1250	1:10	1230	1:14	1195	Coaling up. Air pressure off 5 min.
2:03	1275	2:45	1250			
		2:46	1250			Clinkering. Air pressure off 10 min.
		2:48	1245			
		2:50	1240			Middles dropped 20 deg.
		2:53	1235			
		2:55	1230	3:00	1225	
3:50	1270					Coaling up. Air pressure off 3 min.
3:52	1255	3:59	1255	4:01	1215	
4:40	1275	4:50	1255	4:55	1195	
		5:48	1250	5:59	1240	Clinkering. Air pressure off 8 min
Lowest	1060		900		815	
Highest	1275		1255		1225	Total time pressure off: 1 hour.

COAL-FIELD FURNACE, REGENERATING TYPE

In the following table are listed pyrometer temperatures in degrees C. in the laboratory of the furnace on both sides of the block:

Table 4—Pyrometer Readings in Degrees C. in Coal-Field Furnace

Time		Row No. 1	Row No. 3	Row No. 5	Average
Section 2	3:50 P.M.	1200	1220	1185	1201
Section 8	3:50 P.M.	1220	1230	1175	1208
Section 18	3:50 P.M.	1220	1230	1170	1207
Average		1213	1227	1177	1205
Opposite side:					
Section 2	4:10 P.M.	1230	1235	1120	1195
Section 8	4:10 P.M.	1220	1250	1170	1213
Section 18	4:10 P.M.	1230	1230	1165	1208
Average		1227	1238	1152	1205
General average		1220	1232	1165	1205

CONCLUSIONS

There is too much variation in the volume of gas just before and after coaling up when using 1¼-in. screenings in a Hegeler producer for a non-regenerating type of furnace, due to the rapid combustion of such fine coal. This necessitates more frequent coaling up, and a consequent slight cooling of furnace. The fine coal with no steam blown into the producer forms large lumps of clinker, thus prolonging the clinkering time unduly. By coaling up once an hour there was a sufficient volume of gas of very good quality, and as seen from the temperature record in Tables 3 or 5 the furnace picked up very well during the first stage of the operation. It was, however, very difficult at the latter part of the process to force the backs (*i.e.*, from the 10th to 15th section) without retarding and even cooling off the fronts. The troubles were also aggravated by the increased charging time due to the great amount of producer ash carried into the furnace laboratory, thereby forming an unusual amount of glaze in the furnace bottoms and upon the back lining and retorts. Under these conditions there is hardly any question but that the four-row furnace would at least give the best recovery.

Table 5—Recapitulation and Deductions from Tables 1 to 4; Joplin Ore

Reference	Location	Time When Temperature was Attained of Charging: Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.	Cone 9 1310° C.	Start A.M.	End A.M.
Table 1, part 1	Open retort	1:20	2:57	5:10	7:55	9:48	12:00	1:10		4	9
Table 2, part 2	Open retort	12:40	1:50	3:45	5:40	7:55	10:30	1:15	3:20	5	11
Table 3, column 1	Laboratory*	11:55	1:03	5:00	8:00	10:20	12:20	5:00		5	10
Table 4	Laboratory†	11:00	12:00	2:00	4.00	6.00	8:00	10:00	12:00	5	10

*The approximate time noted on this line was taken from the first column of Table 3, and therefore corresponds to the 4th section only.

†Interpolated from the temperature at four o'clock which was 1205° C. according to Table 4.

An examination of Table 5 seems to show it in error that it indicates temperatures in the laboratory at a later time than the same temperature in the retort. This seems unreasonable, inasmuch as the heating atmosphere must attain a certain heat before the heated body. These comparisons of temperatures, however, are made on furnaces of different type, and merely confirm the actual facts that the furnace in question did not pick up in heat fast enough, and the blue powder could not be worked close enough. Consequently the recovery was unsatisfactory.

Opposite is an analysis of clinker, glaze and slag:

	SiO_2	FeO	CaO	Al_2O_3
Producer clinker	45 5%	15 9%	11 5%	24 3%
Retort glaze	61 6	13 7	4 7	20 3
Furnace bottom slag	53 9	9 5	5 4	27 1

The Gambler

Safety Bulletin, Illinois Steel Co.

A gambler is a man who stakes something of value on an uncertainty. It matters not what that something is. It may be money, health, happiness or life itself, but if he pits it against chance, if he wagers it on a fortuitous turn of life's wheels—he is a gambler, pure and simple. There are many men who would consider themselves defiled if they even so much as fingered a playing card, or looked with sympathetic eye upon a game of chance, who daily jeopardize their lives with unnecessary risk of accident, or injure their health in useless exposure.

It is right enough to have our scruples in connection with those things which the world deems bad, but let us be consistent; let's come clean on this business of taking a chance.

The chance taker is a peculiar menace in the railroad ranks. If, through thoughtlessness, he injures or kills himself, there is untold suffering to those who love him, his own hopes and ambitions stop short of fulfillment and a producer has been removed from his proper place in the general scheme of things.

If, through negligence, of failing to think, the chance taker causes the injury or death of a fellow employee, there must be added to all of the other suffering, a consciousness of his own failure to abide by the simple principles of safety and caution.

It matters not how straight laced a man may think he is, there is something wrong with his morals when he does not feel and constantly endeavor to live safely and sanely, with due regard to his own life and the lives of those about him.

God gives every man the right to live, and if he trifles with that right or with the same right possessed by his neighbor, he is a dangerous gambler and not cognizant of his moral responsibilities.

It's a great mistake to think there is no religion in the rule book. The rule book was not published by a church, but a railroad man cannot be a good churchman, unless he tries to live up to the rule book.

Let's cut out gambling in human life, and try to live straight!

The Research Corporation, incorporated in 1912 by Dr. **F. G. Cottrell** to administer his patents on electrical precipitation of suspended particles, has decided to offer a fellowship of the annual value of $2,500 for the purpose of encouraging scientific research in the development of the industrial arts. The fellowship will be awarded after competition consisting of the submission of evidence of scientific attainments, discoveries or inventions and of special fitness for advanced work. The competition will be decided on Dec. 1, 1917, and the successful candidate will be required to begin his research or investigation immediately. Each fellow is required to present a written report of the results of his work to the corporation at the conclusion of his appointment, but any discovery or invention which he may make shall be deemed his personal property.

Some Notes on Nitrating Kettles with an Example of Acetylation Apparatus

By Frederick Pope

Nitration is ordinarily carried out in metal vessels, sometimes cooled and sometimes heated. For many purposes, however, it is advisable or even necessary that nitration be conducted in vessels of earthenware,

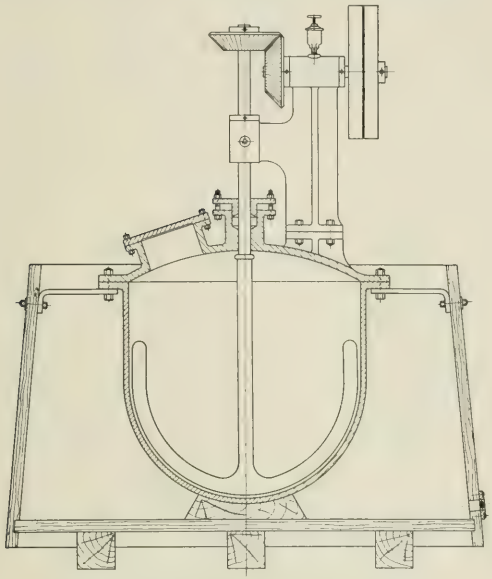

FIG. 1—SIMPLE FORM OF NITRATING KETTLE

glass, enameled or special acid resisting metal such as corrosiron, duriron, tantiron, etc.

The nitrating agent is ordinarily nitric acid, mixed nitric and sulfuric acid, or one of the alkali nitrates, sodium nitrate, for example.

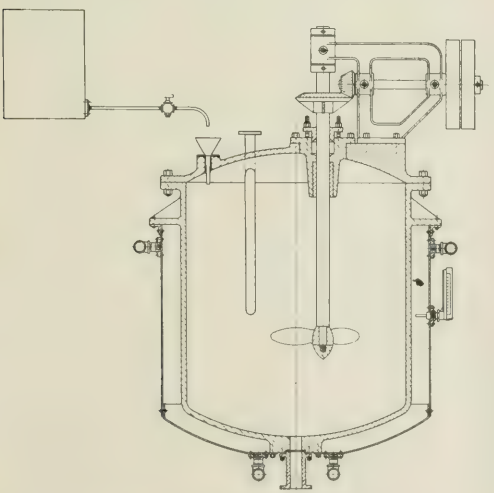

FIG. 2—ORDINARY SMALL NITRATING KETTLE

Fig. 1 shows what is perhaps the simplest form of nitrating kettle, one seldom found in the United States, although not uncommon in Europe. It is a simple cast-iron kettle provided with a mechanical stirring device, set in a wooden tub so arranged that the kettle may be surrounded with either water or ice water. This kettle is discharged either by blowing or with a siphon.

Fig. 2 shows an example of an ordinary small nitrating kettle, arranged for cooling or gentle heating, hot water or low-pressure steam being used in case heating

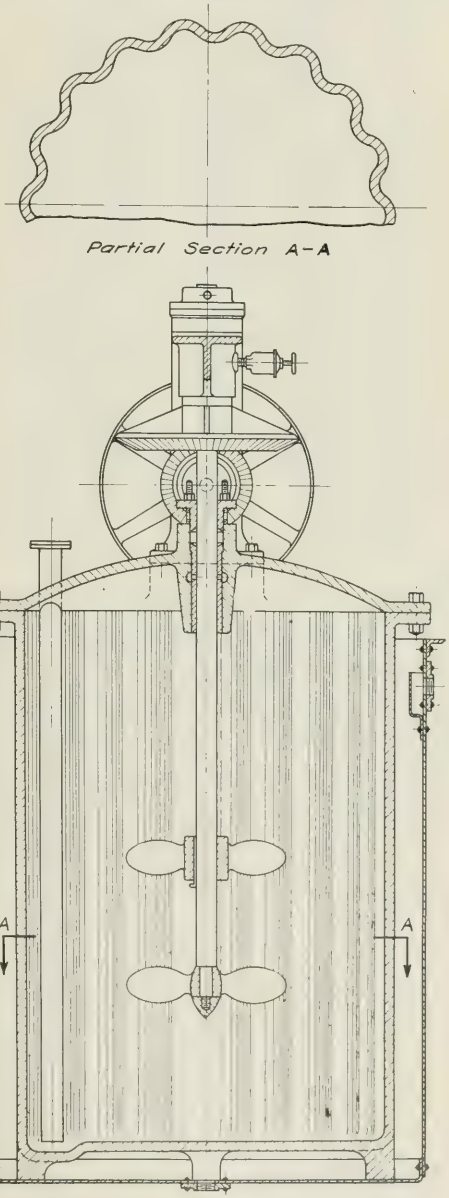

FIG. 3—NITRATING KETTLE WITH CORRUGATED SIDES

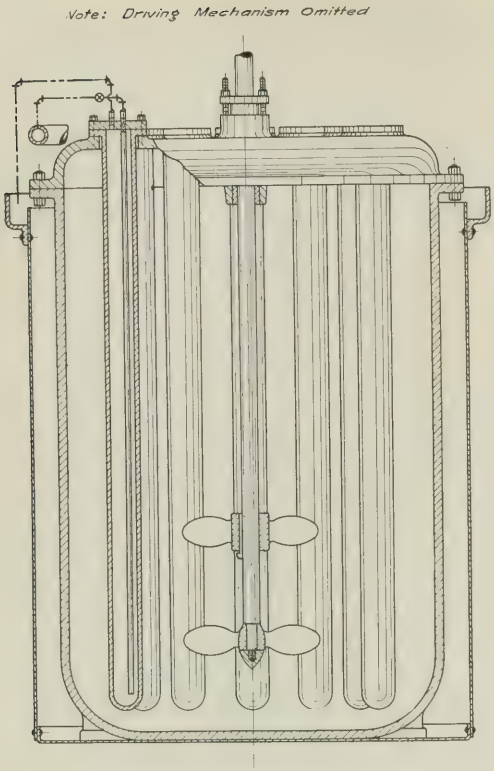

FIG. 4—DESIGN FOR LARGE KETTLES

is desirable. For either brine or water there must be a number of inlets at the top and a number of outlets at the bottom, arranged so that the water or brine in circulation will not channel.

In many instances the rate at which nitration can be carried on is determined by the amount of cooling possible. To promote rapid cooling, a number of expedients have been resorted to.

Fig. 3 shows a nitrating kettle, the sides of which are corrugated so as to present a greater surface for cooling than an ordinary round kettle. This is a somewhat difficult casting to make, and is a type which has not met with very great favor in this country.

Another method is to provide closed-end tubes extending into the liquid in the kettle from the top, as well as a jacket surrounding the kettle. This is illustrated in Fig. 4. By this means the cooling surface is increased very considerably, and this design is used extensively in large kettles. Nitrating kettles of this sort, with a capacity from twelve to fifteen hundred gallons, are largely used for nitrating benzol.

When neither low temperature nor a rapid abstraction of heat is necessary, the cooling is accomplished by cooling water. A kettle equipped with a jacket, such as shown in Fig. 2, is often used.

Fig. 5 shows an earthenware apparatus for nitration. This is set in a vessel so that it may be surrounded with cracked ice or ice water. A tub similar to that shown in Fig. 1 is often used.

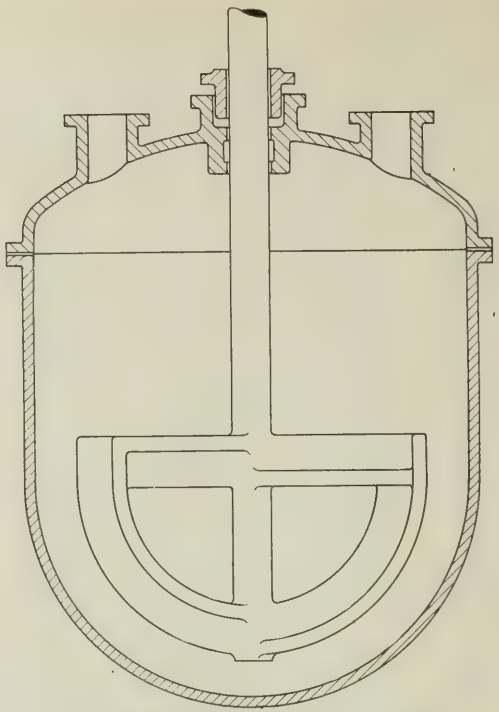

FIG. 5—EARTHENWARE NITRATION APPARATUS

For some nitrations where heating to comparatively high temperatures is necessary we use an apparatus such as shown in Fig. 6. Here the heating is accomplished by steam of a sufficiently high pressure to give the desired temperature or steam superheated to give the desired temperature.

Mononitration and dinitration of a variety of substances are successfully carried out in continuous apparatus. Fig. 7 shows one form of nitrator used for continuous nitration, which has been very successfully used, particularly in the manufacture of nitrobenzol. The cooling here is accomplished by the circulation of water through the coils marked *d*, as shown in the drawing; *a* and *b* are inlets for benzol and acid respectively; *c* is the outlet for nitrobenzol. Accurate results are possible in this apparatus, which is very nearly automatic.

Fig. 8 shows complete apparatus for continuous nitration. Benzol from the tank *b* enters the column *a* through the tube 1. The mixed sulfuric and nitric acid from the tank *c* enters the column through the tube 2. The spent acid leaves the column by the pipe 3, and is collected in the tank *d*. The crude nitrobenzol as produced in the column *a* leaves through the pipe 4 through the watch glass *e*, entering the washer *f*. The wash water enters the washer through the pipe 5 and leaves through the pipe 6. The washed nitrobenzol leaves the washer through the pipe 7, passing through *g*, where it is heated, enters the column *h*, through the pipe 8, which acts as a refining column. The purified nitrobenzol leaves the column by the pipe 9, passing into the cooler *i*. It leaves the cooler through the watch

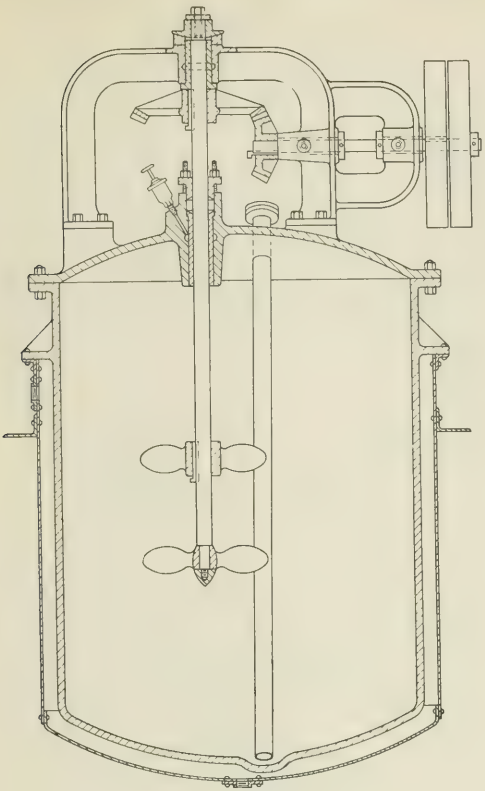

FIG. 6—APPARATUS FOR HIGH TEMPERATURES

glass *j*, enters the separator *k*, where the pure nitrobenzol passes off through the pipe 10 and the water through the pipe 11. The excess of benzol which has been distilled from the nitrobenzol leaves the column *h* through the pipe 12, passes through the partial condenser *g*, enters the cooler *l*, passes through the watch glass *m* and into the separator *n*. The benzol from the pipe 13 is returned to the tank *b*, while the water passes off through the pipe 14. Steam is admitted into the column *h* through the pipe 15. Cooling water for the nitrating column enters through the pipe 16 and leaves through the pipes 17.

A nitrating kettle must always be provided with a cover, usually of the same material of which the kettle is constructed. The joint between the kettle and the cover is usually made with asbestos, rubber or other material, the nature of the joint being determined by the material treated, the material of which the kettle is made, and the pressure to be carried within the kettle. For some materials, asbestos and silicate of soda is very successful.

A variety of agitators are used in nitrating kettles. The off-center propeller, such as shown in Fig 2, is for many purposes the most advantageous. For a large class of nitrations the simple gate type of agitator, such as shown in Fig. 5 for an earthenware kettle, is entirely adequate. Two off-center propellers on the same shaft, the propellers throwing in opposite directions,

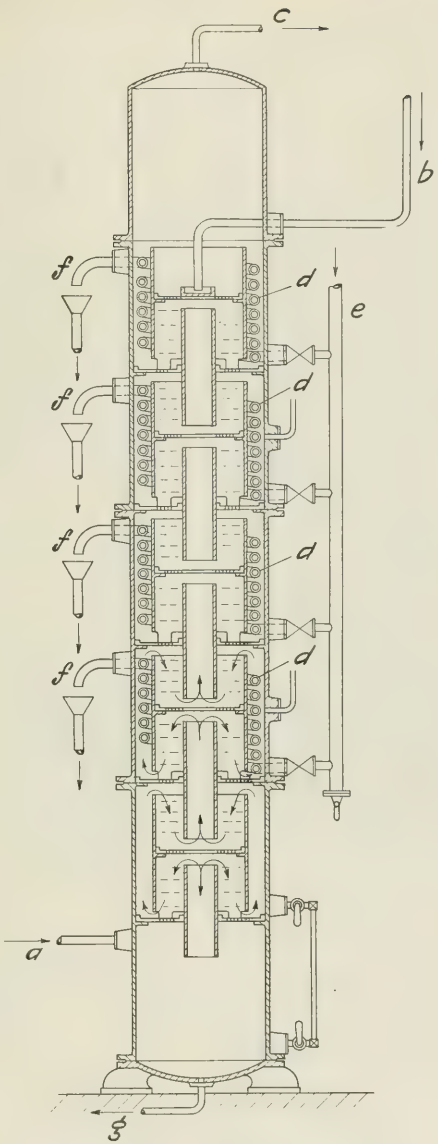

FIG. 7—CONTINUOUS NITRATION APPARATUS

as in Fig. 6, are especially good for large kettles.

When the propeller type of agitator is used, care must be taken that the propeller suits the condition. There is one correct speed for a propeller, which depends upon the size and shape of the kettle, size, form and pitch of the propeller, and the consistency of the liquid in the kettle. With all these conditions determined, there is one correct speed of the propeller. If this is considerably departed from, its efficiency as an agitating device is materially decreased. It follows then that if the consistency of the liquid in the nitrating kettle changes considerably in the course of nitration the propeller type of agitator is unsuitable.

Fig. 9 shows a stirring device which is used when solids such as alkali nitrates are used in nitration. In some cases it is necessary to go beyond the precautions taken here, and the lower blade of the stirring device is made in the form of a rake.

Fig. 10 shows a complete nitrating arrangement where brine cooling is necessary. This would illustrate, for instance, an installation for the nitration of acetanilid, making paranitracetanilid; *a* is nitrating kettle, *b* is an acid reservoir, *c* a brine tank, *d* a brine pump, *e* an ammonia compressor, *f* an ammonia condenser, *g* an ammonia receiver, *h* ammonia expansion and cooling coils, and *i* a reservoir.

The system is too well known to require more than the barest description. Ammonia is compressed and then passed through an ammonia condenser, where it is cooled and then allowed to expand, passing through pipes in the brine tank, and cooling the brine, returning again to the compressor. Cold brine is pumped to the jacket of the kettle, where it abstracts the heat from the reaction, and is then returned to the brine tank. Needless to say one brine tank can be used for a number of nitrating kettles.

In some plants, where exhaust steam and plenty of cooling water is available, the absorption type of refrigerating machine is often advantageously employed.

An Example of Acetylation Apparatus

Acetylation may be carried on in aluminium, silver or silver-lined apparatus. Fig. 11 shows a typical example of an acetylation apparatus which is especially designed for the acetylation of aniline oil in the manufacture of acetanilid. The kettle itself is made of sheet aluminium, with all the joints welded. Surrounding the kettle is an iron jacket, which is set in a furnace fired preferably by gas, but conveniently by either oil or coal, the iron jacket forming an air bath for the kettle. These kettles are also heated by circulating oil, as sulfonating kettles are sometimes heated, but on

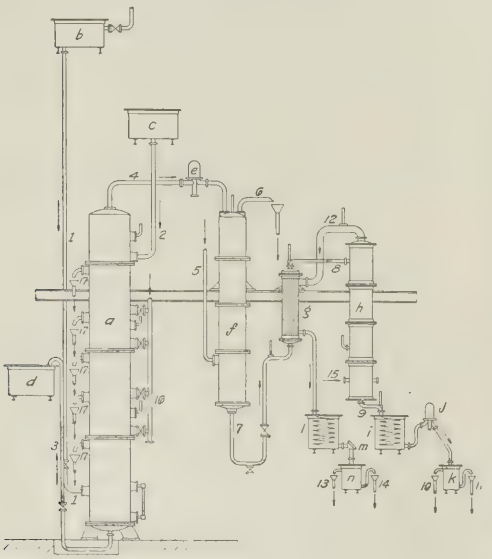

FIG. 8—COMPLETE CONTINUOUS NITRATION APPARATUS

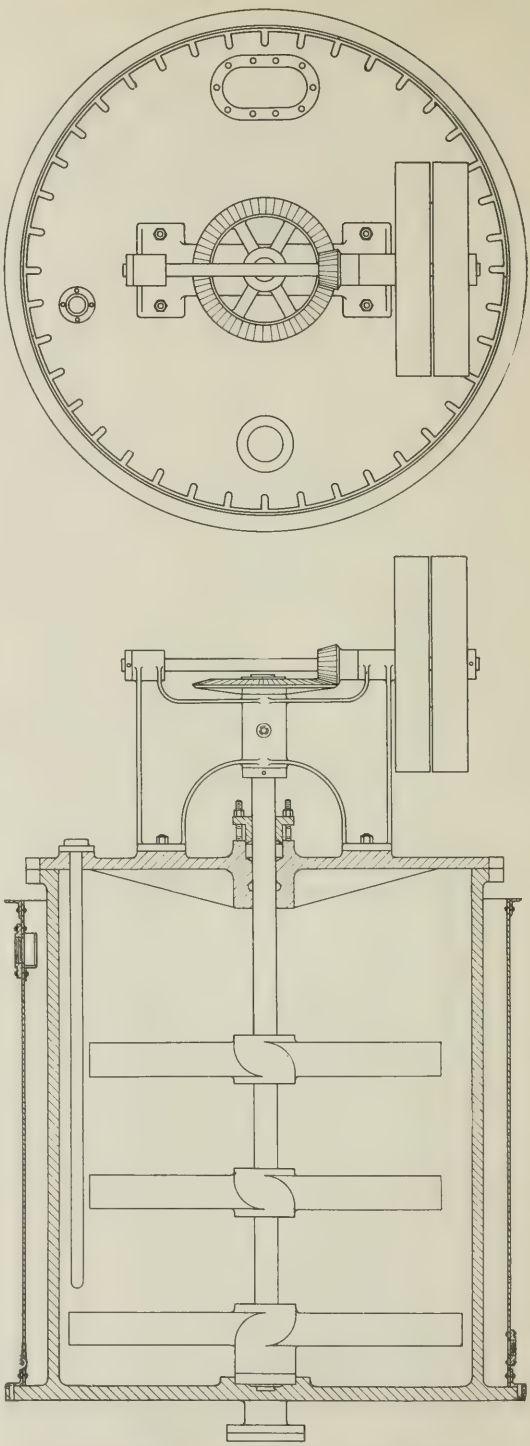

FIG. 9—STIRRING DEVICE FOR USING SOLID NITRATES

account of the high temperature necessary at the end of the operation, the oil circulating method of heating is sometimes troublesome. When heating is accomplished by circulating oil, bottom discharge may be used, but it is fully as convenient to discharge the kettle by means of air pressure through a pipe extending to the bottom, as shown in the drawing.

The kettle is equipped with reflux condenser. This may be the boiling head type, as shown, or it may be a column with Raschig rings, one filled with glass marbles, or simply baffle plates. The use of a boiling deck or a Raschig ring column permits the use of a weaker acid for acetylation.

Connecting to this column is a silver tube

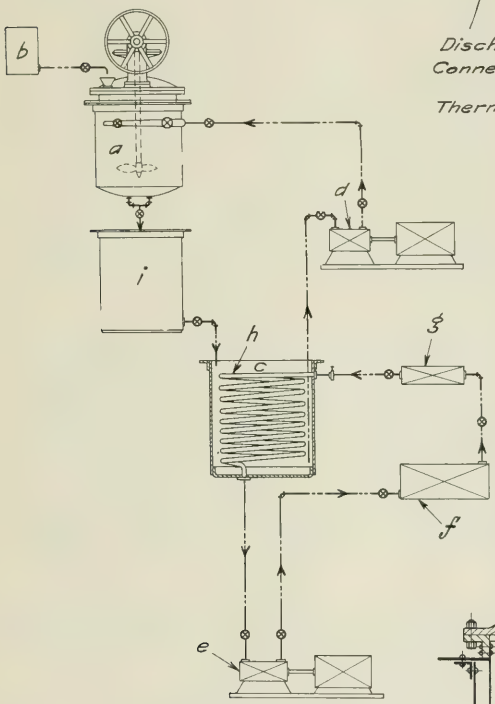

FIG. 10—ARRANGEMENT FOR BRINE COOLING

condenser so arranged that it may be used as a reflux to return the condensate to the kettle, or as a condenser discharging into a receiver. This is managed by the valves marked *a* and *b*. The valves may be earthenware cocks, silver cocks, or a gate valve, very heavily silver-plated. In practice, it is an excellent precaution, in case a silver-plated gate valve is used, to have the plating done twice. A watch glass, marked *c*, is provided at the end of the condenser, so that the operation of the apparatus shall be evident to the operator. The kettle is provided with a silver thermometer tube extending well to the bottom. A recording thermometer should be provided.

The cover, which is bolted securely to the kettle and made tight with an asbestos or silver gasket,

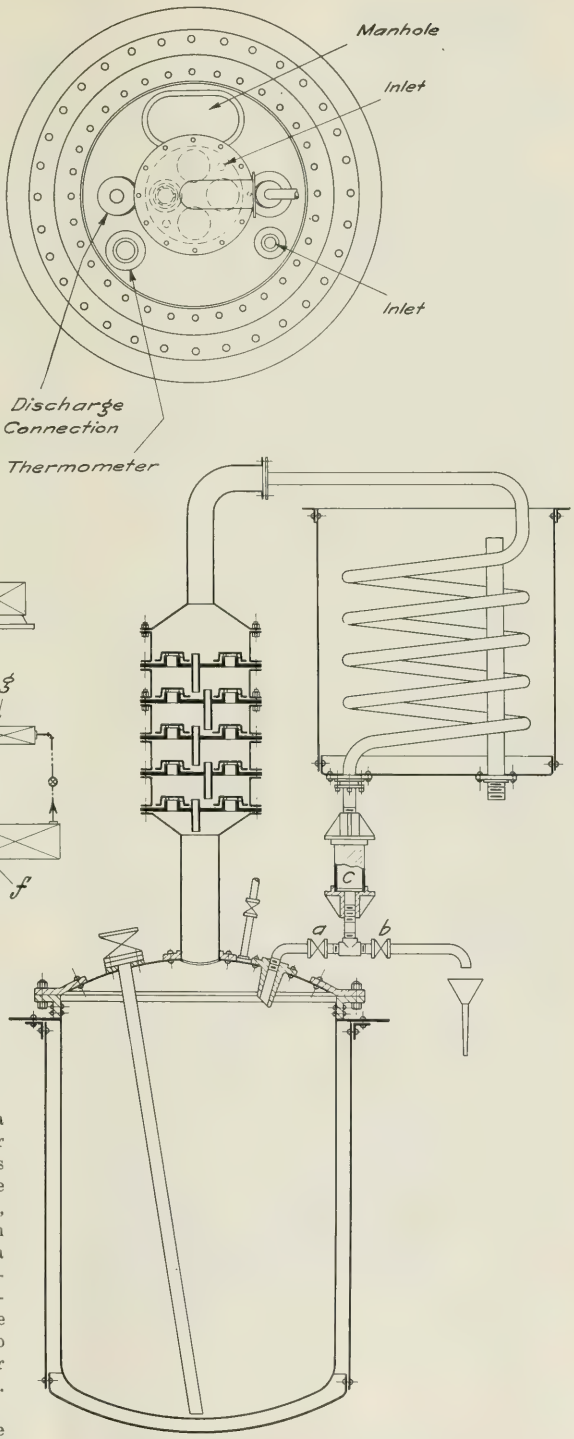

FIG. 11—ACETYLATION APPARATUS

is provided with a manhole, an opening for acetic acid, a separate opening for anilin oil, a separate opening for introducing air to discharge the kettle, an opening for the returns from the condenser, and an opening connecting with the discharge pipe extending to the bottom of the kettle. All these openings must be provided with either silver cocks or silver-plated gate valves.

A very pure sheet aluminium must be used for the kettle, and the joints must be carefully welded. Aluminium solder is entirely inadmissible in any part of the apparatus. The cover is made of sheet aluminium, riveted to a cast aluminium ring, which is in turn bolted to a cast aluminium ring, which is riveted to the kettle.

The boiling head may be made of sheet aluminium. In case boiling decks are used, the decks may be cast aluminium. In case Raschig rings are used, they may be of earthenware, aluminium or silver, and may be contained in a sheet aluminium boiling head. Satisfactory results are obtained from an apparatus such as described when used for the manufacture of acetanilid.

Oxide of Zinc*

By George C. Stone.

The method of making oxide of zinc direct from the ore was invented and developed at the works of The New Jersey Zinc Co. at Newark in the middle of the last century. The process was invented by Burrows, who had not the ability, financial or technical, to work out the details necessary to make it of commercial value. This was done by Colonel Wetherill, whose name is commonly attached to this process. The grate bars used are also frequently called Wetherill grates, which is a misnomer because they were in common use for boiler firing at the time and he never claimed their invention.

The invention of the process was due to the efforts of The New Jersey Zinc Co. to find a profitable means of working the ores from Franklin and Sterling Hill, N. J. These are a mixture of franklinite, willemite and zincite, containing about 20 per cent of zinc. The first attempts were to make spelter, which were not successful, owing to the low grade of the ore and the fusibility of the residue. Failing in this, the next attempt was to make oxide in large muffles and reverberatory furnaces. This succeeded, although the cost of operation was high, the recovery low, and the quality of the product uncertain. In 1855, the new process was patented and has been in successful operation ever since its introduction.

Essentially, the process is to spread a mixture of coal and ore on a body of burning coal on a perforated grate and blow an excess of air through the grate. The zinc is reduced in contact with the coal, volatilized and burned by the excess of air in the upper part of the furnace and in the flues. It is then carried to the bag rooms by the excess air and products of combustion which are forced through the flues by fans. In its main features, the process is the same to-day as at the time of its invention, but the details have been so modified that it would hardly be recognized by its originators.

*A paper to be presented at the St. Louis meeting of the American Institute of Mining Engineers, October, 1917.

ORES

The process is applicable to all the oxidized ores of zinc and to roasted sulphides, provided the gangue is not so fusible as to leave a residue that is impervious to the blast. In many cases the ores contain impurities that make it impossible to produce an oxide of a good enough color to be available as a pigment. These impurities are any volatile metals that form colored oxides or sulphides. Cadmium is one of the worst, because it is very volatile and its dark brown oxide and bright yellow sulphide both have strong tinctorial powers, so that small fractions of a per cent seriously injure the color of the oxide. Lead, which is one of the commonest impurities in zinc ores, also injures the color, though to a much less degree, as it usually forms basic sulphates which are nearly white. On other accounts lead is often objectionable, particularly when the oxide is to be used for the manufacture of rubber goods. Sulphur may occur in oxide as sulphides, sulphates or as sulphurous anhydrides, the first and last of which are objectionable; the first on account of probable injury to the color, while the last is believed by many paint manufacturers to have a bad effect on the grinding properties. Opinion on the latter point is by no means unanimous. Sulphates, if soluble, have very objectionable qualities for outside paints, as they leach out of the paint-coat, leaving discolored spots. Chlorides, in appreciable quantity, are rare, but if present would be open to the same objection.

FUEL

The fuel used must be one that does not give a black smoke, which would ruin the color of the oxide. Anthracite is the most satisfactory fuel for the purpose and the one generally used. In the West, where anthracite is expensive, semi-bituminous coals, low in volatile qualities, are sometimes substituted for it in whole or in part, but they are never as good. Coke alone does not work well, as it causes a very intense local heat that makes the residue impervious to the blast. It is occasionally used as a part of the charge fuel.

FLUXES

With siliceous ores, limestone is sometimes added, but in general it does more harm than good, owing to its tendency to make the residue too fusible.

PREPARATION OF CHARGE

The ores and coal are usually received at the works in fine enough condition for use without further crushing. Nearly all the ores are either concentrates or roasted products and are inevitably finer than is necessary. As the small sizes of coal are suitable for the purpose, and are cheaper than the large, they are invariably used. If fluxes are used they are crushed to about the size of the ore and coal. There should not be a great difference in the size of the different materials, or it will be impossible to mix them properly.

PALMERTON PLANTS

The Palmerton plants of The New Jersey Zinc Co. (of Pennsylvania) are the largest and best equipped oxide plants in the world.

Fig. 1 shows the general arrangement of the West plant and Fig. 2 that of the East. They are similar, but the East plant has fewer and larger bag rooms and

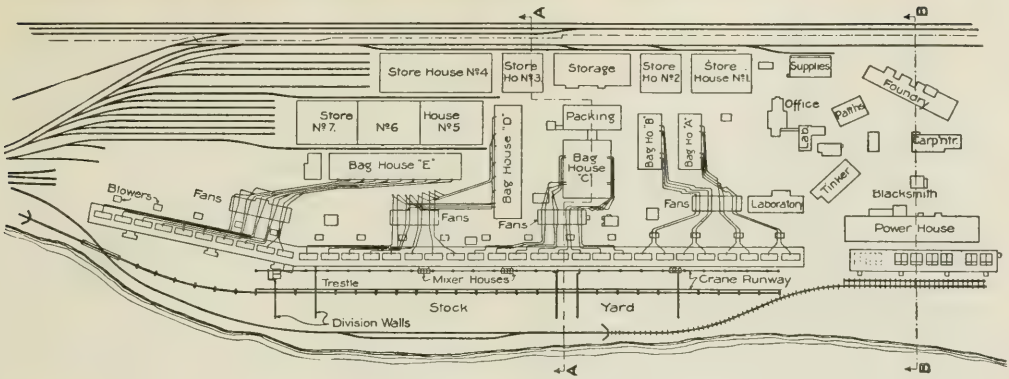

FIG. 1—PLAN OF WEST PLANT

differs somewhat in details. At both plants the raw materials are delivered on the trestle at the south of the plant and are either placed in bins or stocked in piles. The ore and coal are taken from the bins to the mix-house by larries. The mixed charges are delivered to the bins above the furnaces and distributed by traveling cranes. Each block of furnaces is a separate unit, having its own blower, exhaust fan and bag room. The oxide is trucked from the bag rooms to the packing room and the final packages skidded or trucked to the storehouses.

STOCKING AND MIXING—EAST PLANT

The ore and coal are delivered on the double track, steel and concrete trestle, 22 ft. high with Brown tangential bins below the track next to the furnace room. Materials for current use are dumped directly into the bins and the surplus is stocked back of the trestle by a bridge crane of 233 ft. 9 in. span equipped with a 10-ton Brown grab-bucket. This equipment also returns materials from the stock piles to the bins when necessary. The charges are drawn from the bins to a weighing larry which has two hoppers, each containing a furnace charge. These are carried to Ransome concrete mixers placed at one end of the furnace room. The mixed charges are elevated by a pair of counterbalanced skips to bins above the furnaces. From the bins the mixed charge is taken to the furnaces by cranes each having three hoppers holding one-third of a furnace charge each. Each hopper is placed on a scale so that the charge is equally divided between the three.

STOCKING AND MIXING—WEST PLANT

All materials are delivered on a single track steel and concrete trestle 47 ft. high, down the center of the storage yard. The materials are taken from this by a bridge crane of 48 ft. 8½ in. span with a 2-yd. bucket and placed in elevated bins next the furnace room. The ore and coal are stocked and reclaimed by the traveling bridge and by locomotive cranes on the high trestle. The total storage capacity is 200,000 tons of ore and 175,000 tons of coal. The fuel and the various ores are taken by bridge cranes to small bins placed over the mixers. The materials are dropped from these bins into weighing hoppers and from these into the Ransome mixers. The mixed charges are elevated to bins over the furnaces and then distributed by cranes much as at the East plant, except that there are no scales on the cranes or larries. This arrangement of

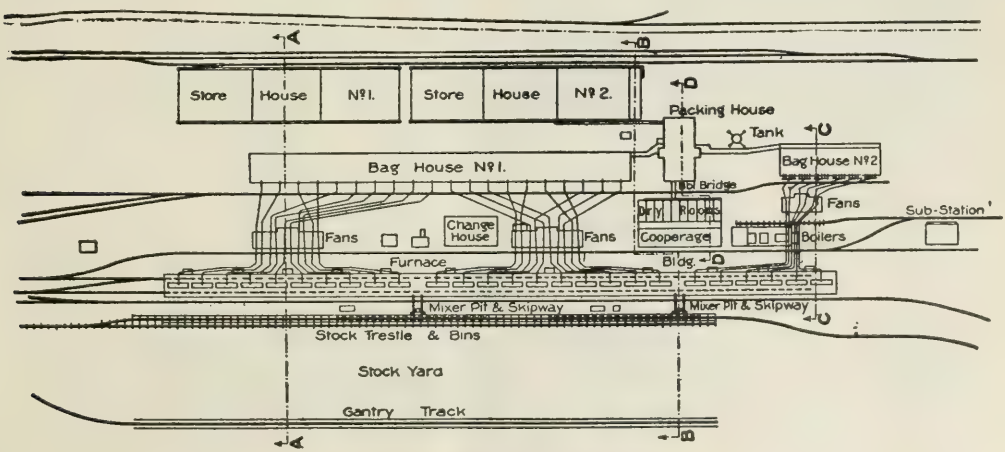

FIG. 2—PLAN OF EAST PLANT

doing all of the weighing at the mixer on a fixed hopper is more satisfactory than weighing larries, because the latter are very difficult to keep in adjustment.

FURNACE ROOMS

The furnace rooms at the two plants are quite similar, the main differences are that at the West plant the furnaces are carried on a concrete foundation and at the East plant on the floor. In both cases the furnaces are elevated sufficiently to allow the residue to be dropped into hoppers below the floor and then into cars. The framing of the buildings is quite different, the East plant (the later one) being arranged to give more room for the charge cranes. The West plant furnace room contains 34 blocks of furnaces and the East plant 26. All the blocks are alike, consisting of four furnaces 19 ft. 6½ in. by 5 ft. 11½ in. (Fig. 5). Each furnace has independent blast and flue connections and three charge openings in the roof surmounted by hoppers. Each furnace works three charges in 24 hr. The different furnaces of the block are charged alternately at 2-hr. intervals in regular order. Charging in this way, there is always one furnace starting, one nearly finishing and two working strongly, and the volume and temperatures of the gases to be handled are nearly uniform at all times.

FURNACE OPERATION

When the furnace is worked off the dampers in the flues are closed, cutting it off from the bag room. The blast is shut off and the working doors taken down. Three men work on the furnace at once, each having a separate door. The loose material on top of the charge is raked off and dropped on the floor close to the furnace. The clinker is then broken up by heavy slice bars and raked into hoppers under the floor. The furnacemen then thoroughly clean the side and back walls from any clinker that has fused to them. When all of the old charge has been removed and the furnace cleaned, the grate is covered as rapidly as possible with a thin layer of coal, the doors closed and a light blast turned on. The coal is lighted by the radiation from the hot arch and it is important that it should light quickly and evenly. When the bed coal is burning brightly, the charge from the hopper is dropped up on it and leveled. The doors are now closed, the blast turned on and the furnace left to itself with occasional inspection to stop any blow holes that may form. With the large charges that are now worked, it is considerable time before any zinc vapor appears. When it does, the dampers in the flues are reversed, sending the gases and oxide to the bag room.

FANS AND PIPING

The blowers for the oxide furnaces are direct-connected to motors, the wheels of the blower being placed on extensions of the motor shaft. They are located in small houses outside the furnace room, two in each house.

Each furnace has two outlet pipes, usually 20 to 22 in. in diameter which lead up to the drum pipe overhead. The drum has an outlet in the middle of its length leading to the exhaust fans. Formerly the gases passed through a brick settling tower between the furnaces and exhaust fan, but this is now usually omitted as unnecessary. The exhaust fans are extra heavy plate fans with special Hyatt roller bearings and water-cooled shafts, belted to motors. Aside from the shafts, bearings and extra thickness of plate, they are of the ordinary types. For convenience in attendance, a number are placed in one building. The West plant has four fan rooms, three containing eight fans each and one containing ten fans. At the East plant there are two with ten fans each and one with six. From the exhaust fans to the bag rooms, in each case, run round pipes 3 ft. in diameter, made of No. 16 sheet iron and provided with numerous clean-out openings. In all cases, the pipes are arranged to give as nearly as possible the same length from furnaces to bag rooms. This is done partly to equalize the friction in the different lines, but mainly to secure proper cooling of the gases before reaching the bag room.

BAG ROOMS

The method of collecting oxide in bags was first patented by S. T. Jones in 1852 and has been patented by others many times since. The bag rooms at Palmerton vary considerably in size; the first two built hold-

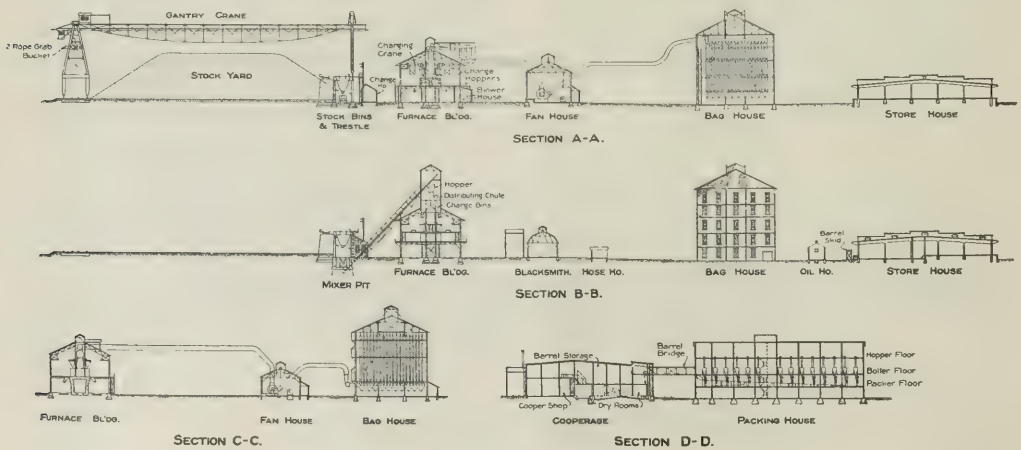

FIG. 3—SECTIONS OF EAST PLANT

ing bags enough for four blocks, while the latest contains the bags for twenty. The larger rooms are more economical in labor and do not cause any inconvenience, provided the ventilation is equally efficient. The bags used are all of heavy, closely woven cotton sheeting 22 in. in diameter and about 40 ft. long In the majority of cases the gases enter a header at the top of the room and from there pass to a series of parallel pipes from the bottom of which the bags are connected to hoppers, four bags to each, with a single collecting bag tied to an outlet at the bottom of each hopper. At intervals the gases are shut off from the two lines of pipe connecting with a single line of hoppers and the bags shaken. This pair of pipes is again connected to the main header and the next two lines shut off and shaken. The frequency with which the bags are shaken depends upon the relative area of grate and bags, and the amount and quality of the oxide being made. The proper ratio of grate surface to bag surface has been a subject of much discussion. It varies in practice between 1:80 and 1:130. The amount actually necessary depends mainly on the efficiency of the ventilation of the buildings and the frequency of shaking. A well-ventilated room will consume no more muslin with a ratio of 1:80 than a poorly ventilated one with a ratio of 1:130. Recent experiments indicate the probability that a well-ventilated bag room with a mechanical shaker operating at short intervals will allow of a very great reduction in the necessary bag area.

The collecting bags are removed from the hoppers every 24 hr., or oftener if necessary, and taken to the packing room. This is done by a trucking gang that removes the filled bags and replaces them with fresh ones, trucking them by hand to one side of the bag room, where they are coupled together and the train drawn to the packing room by a motor.

PACKING

The packing room is a four-story building of mill construction. The trucks are hauled into the ground floor and then taken one by one on a platform elevator to the upper floor. There are a number of openings in this floor leading to bolters on the floor below. Around each opening is a wide shelf on which the bags are rested while their contents are emptied into the bolters. The third floor contains nothing but the bolters, and a room for sewing and making bags. The bolters used are of the ordinary types used in flour mills. The packing machines are arranged in four lines on the second floor. They are also of a type largely used for flour. There is usually one packer below each bolter and fed directly by it. In some cases, owing to the lack of room, one bolter feeds two packers. The oxide is packed partly in paper bags holding 50 lb. each, partly in barrels with 30-in. staves and 19⅛-in. heads holding 300 lb. each, while export material is packed in special barrels and weights to suit the different markets.

The barrels are kept in a storage room where the hoops are driven by a machine and then nailed by a second one, and from here they are passed to the packers. All barrels are weighed empty and filled, the weights adjusted and the barrels headed. They are passed to the ends of the building and rolled on skids to the storehouses. The second floor of the packing room is high enough above the ground level to allow sufficient slope to the skids to carry the barrels to all but the most distant store houses. The paper bags are loaded on trucks and taken to the storehouses on the same skidways.

COOPERAGE

The cooperage is at the East plant, next the packing room. It is fully equipped with machinery and can manufacture about 2000 barrels a day. The barrels are delivered directly from it to the East plant packing room and by special railroad cars to the West plant storehouse.

The storehouses are all one-story mill-construction buildings with the floor elevated to the level of a box car. Each has doors and platforms on opposite sides, one for receiving material from the packing room and the other for loading cars.

POWER PLANT

Power for both plants is supplied from a central station at the West plant between the oxide and the spiegel furnaces. The boiler room is equipped with Edgemoor boilers of 536 hp. each, which can be fired with coal or with the waste gases of the spiegel fur-

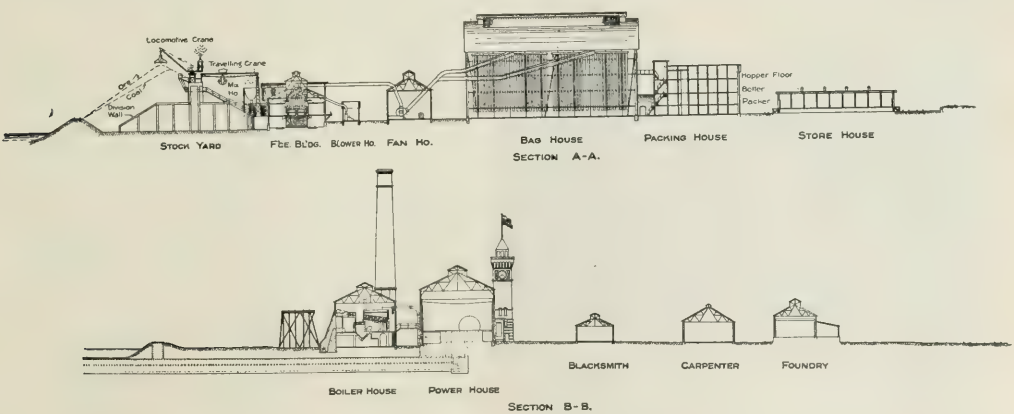

FIG. 4—SECTIONS OF WEST PLANT

naces. The engine room parallels the boiler room and is located about twenty feet north of it. It contains three horizontal cross-compound blowing engines for the spiegel furnace; four direct-current generators, two of 500 and two of 600 kw., each direct-connected to a horizontal cross-compound Corliss engine; three Allis-Chalmers turbo-generators, two of 2000 and one of 4000 kilowatts, 6600 volts, three phase; two motor-generator sets used as a reserve for both alternating- and direct-current lines, as either part can be used as a motor to generate current of the other kind, if needed. In addition, the engine room contains the exciters, condensers and pumps. The engine room is entirely above ground, giving a light basement for the pipes and elevating the machinery above danger from floods. This also permits a railroad track to enter at the ground level, so that new machinery or repair parts can be brought into the building, and there lifted from the cars and put in place by a traveling crane that covers the entire space and can lift the heaviest piece of any of the machines. The switchboards are in a tower at the north side of the building, where they are visible from all parts of the generator floor, but do not project into the room. The tower gives ample room for leads and anchorages of cables.

ORES

The ores used at Palmerton are almost entirely concentrates from the company's mines at Franklin Furnace and at Sterling Hill, N. J. Three of these products are smelted for oxide: franklinite, half/half and dust. The composition of these is about as follows:

	Franklinite	Half/half	Dust
Zn	18.2	18.4	17.6
Fe	35.0	15.2	20.1
Mn	12.8	12.2	8.9
SiO_2	3.6	12.6	7.2

The franklinite is worked by itself and the residue smelted in blast furnaces for the production of spiegel. The half/half and dust are mixed and the residue wasted, as it contains too little Fe and Mn and too much SiO_2 to be a profitable smelting material.

Franklinite is the easiest of these ores to work and gives the best product. The half/half and fines are mixed and worked together. The charges per furnace average:

	Ore	Coal
Franklinite	2.62T	1.62T
Half/half and fines	1.95	1.36

The recovery for franklinite averages about 86 per cent and for the half/half and fines charge about 78 per cent. Both charges and recoveries vary somewhat with changes in the ore and quality of the oxide desired. The recovery and quality of product are controlled by the selection of the ores, ratio between ore and coal and of both to the grate surface, and what is of great importance, the balance of blast and exhaust and the proper proportioning of both to the charge being worked. Where leaded ores are worked the charges and recoveries vary much more and average figures are of little value. In general, with such ores the charges are a little lighter and the recoveries lower than for the New Jersey ores. The recoveries of lead are usually rather better than of zinc, roughly as 9 to 8. For estimating purposes the make of oxide is generally

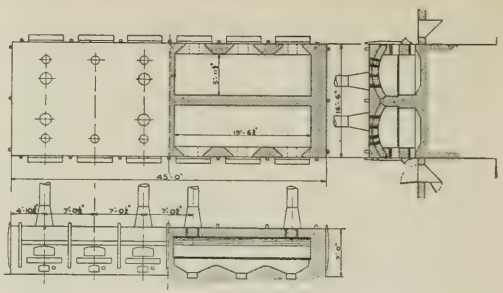

FIG. 5—FURNACES

taken as equalling the combined Zn + Pb in the ore, the gain in O and SO_3 about balancing the losses in Zn and Pb.

PRODUCT

The product is divided into five grades, two for the use of paint manufacturers, two for rubber and an off-grade that is reworked either for oxide or spelter. For the paint trade, the grading is entirely by color, samples being daily rubbed down with oil and compared with standards. For the rubber trade, slight variations in color do not make so much difference and the grading in this respect is not so close, but freedom from lead and absence of small hard particles is insisted upon.

The variation in composition of the different grades is very slight, the range of composition of all being nearly the same. The material as shipped uniformly contains 99 per cent or over ZnO, the principal impurities being: SO_3, 0.25 to 0.33 per cent; H_2O, 0.10 to 0.50 per cent, and PbO, 0.05 to 0.30 per cent.

The principal use of zinc oxide is as a paint pigment and for this purpose its purity of color and freedom from discoloration by gases and atmospheric conditions, fineness and uniformity make it particularly useful. As a pigment it has the disadvantage of slow drying and a tendency to become unduly hard in time. The general consensus of opinion among paint manufacturers now is that a mixture of pigments is better than any single one. In these mixtures, zinc oxide is an almost invariable constituent because it prevents chalking and gives a surface that retains its color.

Next in importance is its use in rubber goods. In the manufacture of such products, zinc oxide is used for two purposes. It is used as a pigment to produce white goods, and is excellent for this, provided it is substantially free from lead. If this were the only effect it had it might be replaced by cheaper materials, but it also greatly increases the tensile strength of the resulting material. A mixture of pure rubber and sulphur vulcanized has a tensile strength of about 2000 lb. per square foot and an elongation of 960 per cent of its original length. The effect of adding zinc oxide is to increase the tensile strength but diminish the elongation as shown in Table 1.

TABLE I

Per Cent ZnO	Tensile Lb. per Sq. In.	Elongation, Per Cent
25	2,400	720
35	2,400	700
45	2,700	680
55	2,500	620
65	2,000	540
75	1,300	400

It will be seen that up to about 60 per cent, ZnO increases the tensile strength of rubber. No other material tested has this effect.

As the supply of lead-free ores is limited and the demand for ZnO is increasing, much more leaded oxide is being made. The process is the same but the charges are usually lighter and the recoveries lower. In most cases the furnaces used are double ended with one or two working doors at each of the opposite ends. This makes the furnace easier to clean, as there is no back wall, which is the most difficult part from which to cut accretions. On the other hand, this type of furnace cools off more when charging and does not, as a rule, light up as quickly. Which type is better is still an open question, the users of each claiming that theirs is superior. In making leaded oxide, it is customary to have a brick combustion chamber over, or close to, the furnace. This insures a sufficient time of contact at a proper temperature to cause the lead to be converted into basic sulphate. This is essential, as all of the oxides of lead are strongly colored and injure the color of the product, while the basic sulphate is very nearly white and does not have this effect. In many cases the bag rooms of the works making leaded oxide have no overhead distributing pipes, the hoppers being connected and used for this purpose.

Leaded oxide is divided into several grades, depending on the amount of lead it contains. This is always stated as the amount of neutral sulphate ($PbSO_4$) equivalent to the total lead present, although it is always present mainly as a basic sulphate. It forms an excellent material for the manufacture of mixed paints. So far this grade has not proved satisfactory to the rubber manufacturers.

PRODUCTION

It is impossible to give production of oxide of zinc, as the statistics are not published by the Government. Such figures as have been published are not comparable, because the grouping of the different products is not always the same. The increase has been very rapid, especially within the last three or four years.

New York City.

Club for American College Men in Paris.—The establishment in Paris of a home club for American college men or their friends who may be in the French capital for military or other service in the cause of the allies is contemplated by the American University Union in Europe, which has just been organized in this country. The privileges of the club will include information bureau, writing and newspaper room, library, dining room, bedrooms, baths, social features, medical advice, etc. The union also expects to provide headquarters for the various bureaus already established or to be established in France by representative American universities, colleges, and technical schools. It will cooperate with these bureaus when established, and in their absence to aid institutions, parents, or friends in securing information about college men in all forms of war service, reporting on casualties, visiting the sick and wounded, etc.

The University Union will have its headquarters in Paris with branch agencies in London and such other cities in allied countries as may seem desirable. Its office in America will be in or near New York City.

The Production of Salt in Szechuen Province, Western China—III

By H. K. Richardson

THE WELLS OF KWEI-CHOW FU

In two former articles* the medium and deep salt wells of the province of Szechuen were described. This article will deal with the shallow wells, most particularly those at Kwei-Chow Fu.

Kwei-Chow Fu is situated on the Yangstze River just over the border in the Province of Szechuen as one travels up the river (see map in first article). The wells in question are situated 5 miles east of the town on both banks of the river. Those on the southern side are small and of little importance; the most important producer is a single well on the northern bank of the river. This well only operates a few months a year, for it is dug on the shingle bank of the river that is under water at the high stage of the river. When the river recedes in October the well is dug out and work continues night and day, no stopping on Sunday, until the spring freshets in April inundate the bank carrying stone and gravel into the well hole and filling it up. The sides of the well are made of permanent stonework, so that all that is needed the next season is to locate the well and clear out the débris and make a few repairs to the retaining wall. Fig. 1 shows the situation of the well on the river bank, surrounded by the shacks in which the workers live during the season. The evaporators are all nearby the well, so there is always steam arising from the settlement, while by night the light of the many fires makes one think of a small steel village.

The well is an open pit some 35 ft. deep and about the same in diameter. The well or spring itself is enclosed by a stone facing 12 by 12 ft., which also serves as the landing stage from which the brine is dipped into the coolies' buckets. Fig. 2 shows a general view of the well. Access to the bottom is obtained by three flights of stairs made of stone and worn smooth by many years of use.

All the brine is carried to the top in buckets by coolies. Figs. 3 and 4 show the coolies lined up to fill their loads. Fig. 3 was taken when brine was plentiful, so no one was afraid of not getting his share, while Fig.

*This Journal, Jan. 1, 1917, and Sept. 1, 1917.

FIG. 1—SALT VILLAGE ON NORTH BANK OF YANGSTZE RIVER, 5 MILES EAST OF KWEI-CHOW FU. SHINGLE BANK IN FOREGROUND IS COVERED AT HIGH WATER. RIVER FLOWS AT FOOT OF MOUNTAIN IN BACKGROUND

FIG. 2—BOTTOM OF WELL. GENERAL VIEW, SHOWING RETAINING WALL AND FLIGHT OF STEPS. COOLIES CARRYING BRINE UP STEPS. LANTERN SLUNG ACROSS FOR NIGHT WORK

4 was taken at a time when brine was scarce and everyone was after more than his share. In the latter photo about a dozen naked men were down in the well scooping up the brine with a bucket and filling those of the coolies. The brine when brought to the top of the well is dumped into a half-barrel containing pebbles; the brine overflows from this head tank into wooden sluiceways 5 in. wide by 3 in. deep, and finds its way to the evaporators. Fig. 5 shows the edge of the head tank

FIG. 4—BRINE SCARCE—EVERYONE BUSY AS BEES TO GET HIS SHARE. NOTE BUCKETS ON CARRYING POLES

and the sluiceways. Each evaporating unit consists of a storage pond, two filters and three evaporating pans and their furnaces. The brine coming along the main sluiceway is shunted to the respective ponds by a valve of hard clay balls. The storage pond is made by hollowing out a depression in the hard clay and hammering the clay solid. Sometimes lime is added to the surface of the clay. These ponds are 20 ft. long, 12 ft. wide and 2 ft. deep.

The brine from the storage pond is dipped into two filtering barrels, these barrels being filled with clay balls about 2 in. in diameter. Some of these balls are in reality salt brick. In seasons of plentiful supply of brine some of the brine is poured out over the clay surrounding the chimney of the furnace and all the water evaporated off. This process is repeated until the clay is saturated with salt and becomes very hard when it is broken up into the clay balls above mentioned. Fig. 6 shows one of these chimneys. These clay balls are then stored against the time when the well fills, and there is a little interval that the pans can be worked before they are flooded. They also serve as the filtering material, cleaning out the dirt and also leaching out their contained salt, thereby increasing the degree of saturation of the brine and increasing the fuel economy. Their use is apparently unique in this well, and is a fine illustration of efficiency of operation and ingenuity in making the best of a situation.

The clear brine is piped from the filters to the first evaporating pan, into which it drips constantly. Here it is concentrated until salt appears around the edges, when it is dipped over into either of the other two pans. From these two pans the crystals are constantly

FIG. 3—BRINE PLENTIFUL—WATCHING THE FOREIGNER MORE THAN THEIR JOB

FIG. 5—HEAD TANK TO SLUICEWAYS. GRAVITY FEED TO STORAGE TANK AT EVAPORATING PANS

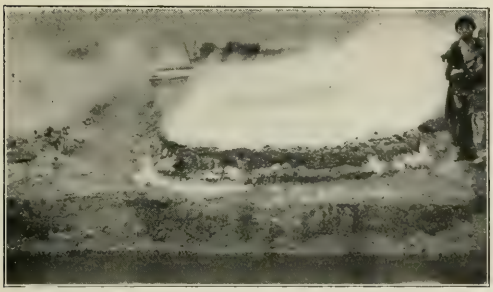

FIG. 6—CLEANING OF PANS. MAKING SALT BRICKS

collected and allowed to drain in a V-shaped wooden trough. Fig. 7 shows a top of a pan and the crystal drainer. When the layer of salt formed on the bottom of the pan slows up the evaporation too much the brine is allowed to evaporate to dryness and the hard salt cake is removed and sold for distant traffic.

Each pan is set over its own furnace, which is very simple in construction; a hole 6 ft. in diameter and 7 ft. high is dug in the ground and lined on three sides with pounded clay, the front or fire side being closed up with mud brick or stones. The furnace is carried up 4 or 5 ft. above ground and tapered in to receive an iron pan 3 or 4 ft. in diameter. The pan is made of cast iron ⅛ in. thick and is 9 to 12 in. deep in the middle. This pan is carefully luted on the top of the furnace, so that all smoke must pass out of the holes at the back of the furnace and up through the chimney described above. Fig. 8 shows the fire side of one of these furnaces. The fire bed is about 8 ft. below the bottom of the pan, allowing of complete combustion of the fuel.

The fuel used in these furnaces is a slack coal mixed with mud to make briquettes. The coal of this region is mined several miles up a small stream and floated down in small boats. Since the coal is very friable there is much small material; this fine stuff is mixed with considerable amounts of clay and made into briquettes 3 by 2 by 5 in., which are sun dried and then used. They make a good fire that burns slowly and evenly. Their most important objection is the amount of sulphur dioxide given off. Fig. 9 shows one of the numerous briquette factories, or rather yards, on the beach. A careful look at the picture will disclose the entire mixing and molding outfit.

The operations of the plant are best seen from the following flow sheet:

Brine in well.
↓
Carried by coolies—using buckets and shoulder poles.
↓
Dumped into head tank of the sluiceways.
↓
Runs by gravity to the storage ponds at the evaporators.
↓ ↑
↓
Dipped to chimney rim during season of plenty of brine ..... ↙
↓
Dried to salt bricks.
↓
Broken up.

Dipped to filter
↓
Placed in filter
↑ ↓
Clear solution.
↓
Allowed to drip into pan No. 1.
↓
Dipped to pan No. 2 or 3
↓
Salt crystallized out by boiling.
↓

Mother liquor.
↓
Evaporated to dryness on pan.
↓
Pan scale broken up and Marketed.

Crystals.
↓
Drained dry.
↓
Marketed.

The well is the property of 100 families, who share the ownership of the well on the community idea, and all others must keep out. Each family erects its own straw hut on their section of the beach at the beginning of the year's season and the whole family helps in the work, living on the spot. Each family sections off its pans, storage ponds and hut from the others. Each family does its share in cleaning out the well at the beginning of the season, and must share in the building of the sluiceways to its pans. There is no charge made for the brine, each family hires the number of coolies it needs to supply its pans and then they have regular shifts for the day and night work. Each family is entitled to the use of four evaporating pans, however

FIG. 7—EVAPORATING PANS AND STRAINERS

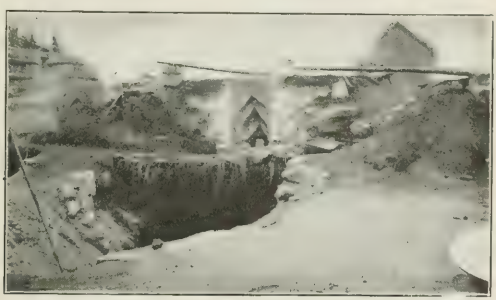

FIG. 8—FIRE SIDE OF FURNACE—CHARGING DOOR FOR COAL

the average per family is only three, making about 300 pans in operation.

The brine obtained from the well is very weak; the owner of one of the pans told us that he recovered only 6 to 8 oz. per load of brine; this would mean about a 0.4 per cent solution of sodium chloride. He also stated that he produced 120 or 110 or 100 catties of salt per day and night per pan, depending on how long the pan had been run and how thick the pan scale became. When they only produced 100 catties the pan scale was removed and the pan started over again. The average yield per three pans per day was 340 catties or 453 lb. of salt ready for the market. This same man gave us the figures of 2133 lb. of coal used per 133 lb. of salt produced. This would give 15.6 lb. of water evaporated per pound of coal; this would be too high if only the weak brine is considered, but since bricks are extracted and the brine strengthened this figure is unreliable for calculating the evaporation of water.

The balance sheet of this operator is of interest.

INCOME PER MONTH		
13,600 lb. of salt at 2c per lb		$272.00
EXPENDITURES PER MONTH		
Labor—6 brine carriers at $2.00 per month	$12.00	
—3 furnace men at $4.00 per month	12.00	
Food for the above nine men	7.20	
		$31.20
Coal—108.8 tons at $0.87 per ton		94.66
Salt tax at 1/2c per lb		68.00
Depreciation of pans and repairs:		
Cost of furnace	$13.00	
Cost of furnace pans	3.00	
	$16.00	
In use for 7 months then furnace total loss, pans salable for other purposes at low price so assume a total loss		2.29
		$196.15
Monthly profit		75.85

Out of the above profit we can justly deduct the slight cost of marketing the salt, the cost of erecting the buildings each year, the annual cleaning out of the well, and the erecting and taking down of the sluiceways, etc., each year. These all told should not exceed $50 in a season, so with a gross profit of 7 × $75.85, or $530.95, there is still a net profit of $480.95 per season. This is a princely sum for a Chinese family, and does much to explain the care with which the family watches the work. It is very probable that considerable graft or "squeeze" money was paid to officials from the net profits. There is practically no permanent investment, since the pans and furnaces are used only seven months a year and then lost under the rising waters of the river.

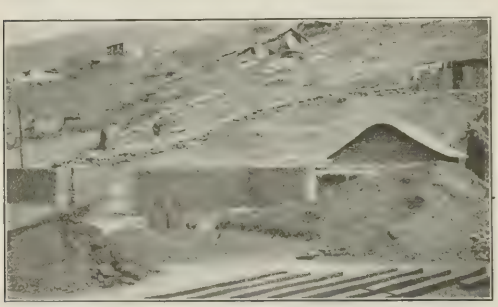

FIG. 9—BRIQUETTE YARD ON RIVER BANK AT KWEI CHOW FU

There are two other shallow wells that supply a much larger amount of salt than that at Kwei Chow Fu. These are the wells at Yun Yang Chang and Da Ning Chang. As far as I know these have been visited by only one white man, Rev. Mr. Hannah of the China Inland Mission of Kwei Chow Fu. The following data was given to the writer by Mr. Hannah:

WELLS AT YUN YANG CHANG, 7 MILES NORTHWEST OF YUN YANG HSIEN

The wells are about 10 to 20 ft. in diameter, walled with stone down as far as can be seen. They vary in depth from 100 to 200 ft. The brine is raised in small buckets holding 2 gals. Two buckets are attached to the end of a rope, the rope thrown over a sheave so that when an empty bucket descends to the well a full bucket ascends. At the large wells there are twenty to thirty of these windlass lifts arranged around the periphery of the wells; they are manned by coolies stripped to the waist. Each coolie has a rope around his waist to prevent him from falling into the well. The brine evidently comes from an underground spring and is very clear, needing no filtration. Coal from an adjoining hillside is used to evaporate the brine.

WELLS AT DA NING CHANG, 10 MILES FROM DA NING HSIEN

The brine at this place is obtained from a spring on a hillside. The spring is a hole about 4 ft. in diameter; the brine flows from the spring by gravity directly into a large concrete (Chinese style) reservoir. From the reservoir bamboo tubes lead the brine directly to the evaporating pans situated on the hillside at a lower level. The brine is allowed to run continuously into the pans. The brine is clear and needs no filtration. Coal is used as at Kwei-Chow Fu for the evaporation.

The relative productions of the various classes of wells is obtainable from data collected by Sir A. Hosie in 1904. The data given below is from his compilation for 1902 or 1903:

Type of Salt Well—Situation		Production Catties (1.33 lb.)
Deep wells, 3000 ft. over:		
Tzu Liu Tsing		274,000,000
Medium wells, about 1000 ft.:		
Ch'en Wei Hsien and Kiating Fu	141,100,000	
Tai Ho Chen district	2,700,000	
Chien Chow district	7,300,000	
Unclassified, mostly medium wells	5,000,000	
Total		156,100,000
Shallow wells, 200 ft. and under:		
Yun Yang Hsien	25,500,000	
Da Ning Hsien	9,900,000	
Kwei Chow Fu	2,700,000	
Yen Yuan Hsien	1,300,000	
Total shallow		39,400,000
Grand total		469,500,000

Changing the above figures to American tons we get the following table:

Type of Well	Tons of Salt	Per Cent of Total
Deep wells over 3000 ft. deep	182,600	58.3
Medium wells, mostly about 1000 ft.	104,100	33.3
Shallow wells, mostly under 200 ft.	26,300	8.4
Total	313,000	100.0

The value of the 313,000 tons of salt at 2 cents per pound is $12,520,000, which is a considerable yearly business even in U. S. A., and means a very large business in a country like China. It would be hard to estimate accurately the number employed in this industry, but it cannot be far from 1,000,000 hands.

The Milling Practice of the St. Joseph Lead Co.*

BY L. A. DELANO,[1] E. M.

During 1916, the St. Joseph Lead Co. milled 2,505,670 tons of ore. This is a daily operating average of 7855 tons. The economic concentration of such a large tonnage necessarily requires a plant equipped with modern machinery and operated efficiently. The milling process used in producing this output has been a gradual development through the long period of years that the company has been in existence.

*A paper to be presented at the St. Louis meeting of the American Institute of Mining Engineers, October, 1917.
[1]Mill Superintendent, St. Joseph Lead Co.
[2]Trans. A. I. M. E. (1888-89), 17, 659.

HISTORICAL SUMMARY OF MILLING PRACTICE

Ore was first mined at Bonne Terre, Mo., in 1864. The early milling practice was crude. It consisted of breaking the ore into small pieces by hand, pulverizing in a Blake crusher and a pair of Cornish rolls to approximately minus 6 mm., and jigging in the old-fashioned hand jigs. Only the coarse heavy galena was saved, the gangue being shoveled off and discarded. The output for the first year under this method was only 240 tons of pig lead.

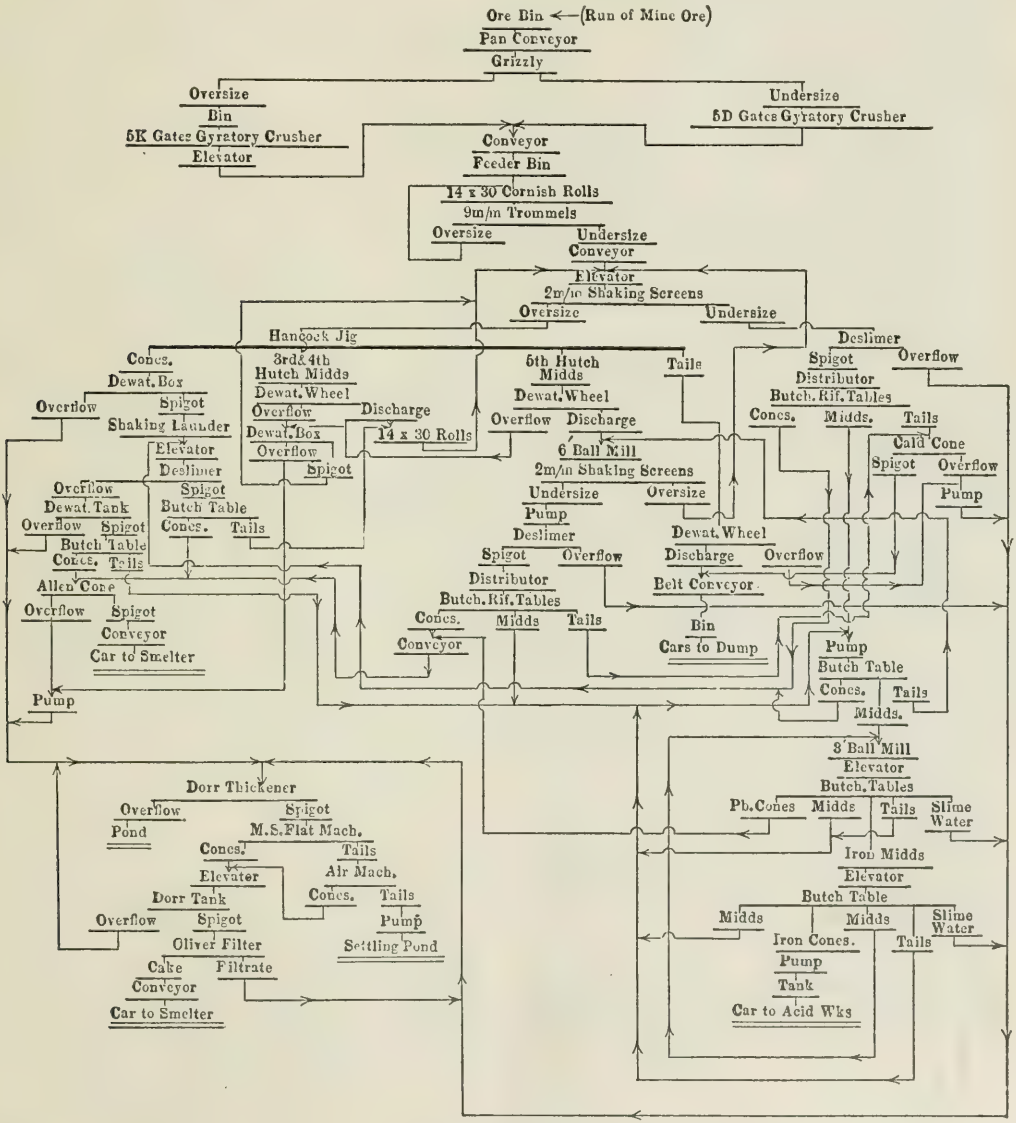

FIG. 1—FLOW SHEET BONNE TERRE MILL

The first mill of the company was a combination of extensions and additions built from time to time as the mines developed. It was a museum of early milling machinery, such as jigs, percussion tables, buddles, dolly tubs, log washers, etc., following no definite flow sheet. The chats, or tailings, were hauled to waste dumps by mule and ox teams, as much as 500 tons per day being moved in this manner, until a railroad was built in 1880. This mill was burned in 1883, at which time the annual output had reached approximately 7300 tons of pig lead.

A new mill of 500 tons capacity was designed and built by C. B. Parsons. This mill has been admirably described by H. S. Monroe.[2] The ore was crushed in Blake crushers, Cornish rolls, through 6-mm. screens, and treated by jigs of the Parsons type, percussion tables and log washers, or trunking machines, for cleaning the galena. The middlings were recrushed in rolls and treated on Harz jigs. The mill was operated without change, except later installing Gates crushers and enlarging the capacity to 1200 tons, until 1910, when Wilfley tables replaced those of the Rittinger type.

In 1904, a new mill was built at Leadwood, Mo., with a capacity of 1200 tons daily. The ore was crushed in Gates gyratory crushers and high-speed rolls, and concentrated on Harz jigs and Wilfley tables. In 1906, the Hancock jig was introduced to the district in this mill.

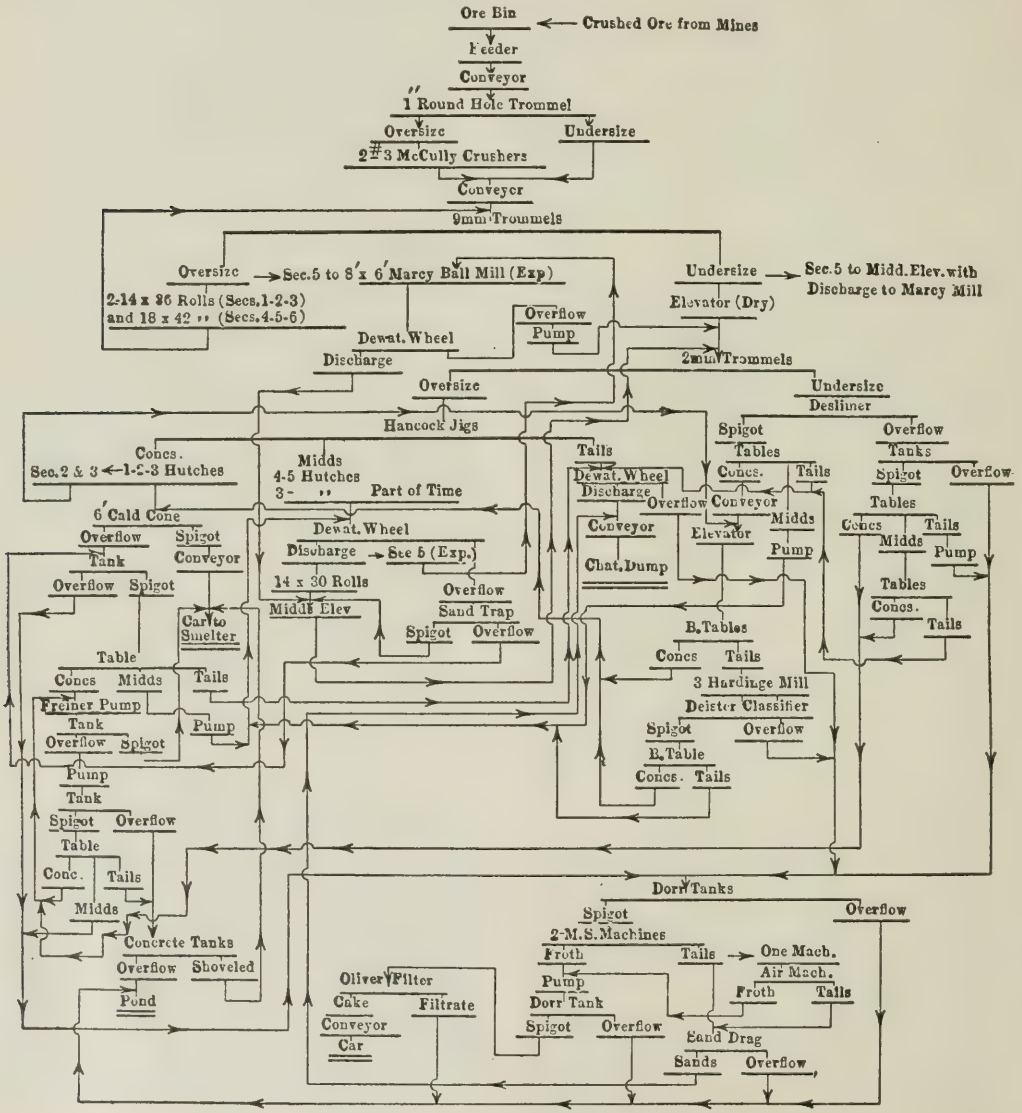

FIG. 2—FLOW SHEET OF D. R. L. CO.'S NO. 3 MILL, RIVER MINES, MO.

In 1909, the Doe Run Lead Co., now a subsidiary of the St. Joseph Lead Co., built a 2400-ton mill at Rivermines, Mo., which in 1913 was enlarged to handle 3600 tons per day. This plant received ore crushed to 4 in. at the mines, and, after reducing to 9 mm. at the mill, concentrated it on Hancock jigs and Wilfley tables.

In 1912, the Bonne Terre mill was partially remodeled, Hancock jigs, Richards classifiers, and automatic disposal of mineral and chat were installed, increasing the capacity of the plant to 1600 tons daily. In the spring of 1914, the flotation process having been applied to lead ores by the Federal Lead Co., it was installed in the three mills of this company for the treatment of the slimes. The application of modern crushing machinery, jigs, tables and flotation has resulted in the present system of milling with the ability to handle large tonnages economically.

DESCRIPTION OF THE PLANTS

The ores are milled at three plants, namely, Bonne Terre, Leadwood and Rivermines. Daily tonnages milled at each plant are: Bonne Terre, 2100; Leadwood, 1750; and Rivermines, 4000.

The mineral, galena, is disseminated in magnesian limestone or dolomite. It is associated with some pyrite, marcasite, chalcopyrite and sphalerite, and carries a small amount of silver. The ore in part of the mines runs high in chlorite (glauconite), and contains a rather large percentage of insolubles. The galena is massive, crystalline to fine granular in character and disseminated in the dolomite. The ore has a specific gravity of approximately 2.8, and a hardness of 3.5.

The flow sheets of the three mills are shown in Figs. 1, 2 and 3. In this paper a complete description of the Bonne Terre mill practice will be given, and then contrasted with the operation at the Leadwood and Rivermines mills, showing the principal differences in each plant.

THE BONNE TERRE MILL

The ore is hoisted to a bin of approximately 22 tons capacity. From this bin it is conveyed by pan conveyors to two No. 5 style D Gates and one No. 5 style K Gates gyratory crushers. A screen analysis of run-of-mine ore feeding the crushers is shown in Table 1.

TABLE 1—SCREEN ANALYSIS OF ORE AT THE BONNE TERRE MILL

Size	Per Cent Weight
On 10 mesh	11.1
On 8 mesh	12.6
On 6 mesh	7.6
On 4 mesh	32.5
Through 4 mesh	36.2
Total	100.0

Grizzlies with bars spaced with 7½-in. clearance are set on an incline over the two No. 5 D crushers that crush the undersize. The oversize gravitates to a small bin and is crushed by the No. 5 K crusher, and is then elevated by bucket elevator to pan conveyors, which convey all the crushed discharge to belt conveyors. These belt conveyors distribute the ore to feeder bins, scrapers being used to rake it off into each bin. Messiter electric scales attached to the pan conveyors receiving the discharge from the crushers were used for a time, but have been discontinued because of difficulty in keeping them accurately regulated. Table 2 shows a screen analysis of the crusher discharge.

TABLE 2—SCREEN ANALYSIS OF CRUSHER DISCHARGE

Opening Diameter	Weight, per Cent	Opening, Diameter	Weight, per Cent
+3 in.	12.9	+1 in.	14.9
+2½ in.	11.4	+9 mm.	12.5
+2 in.	17.6	+2 mm.	9.9
+1½ in.	15.7	+150 mesh	3.5
		−150 mesh	1.6
		Total	100.0

The same Cornish rolls that were installed in the mill when it was built in 1883 are still in use. Thirteen sets are used, fed by Challenge feeders. The shells are 14 by 30 in., one chilled cast iron and the other chilled steel is used on each set. A groove ¾ in. deep and 1½ in. wide is cut across the face of each steel roll shell to prevent slipping of the ore and consequent grooving of the shell. The roll speed is 10 r.p.m. Weight boxes are used on the rolls instead of springs. The roll discharge is screened through a 9-mm. trommel, 3 ft. diameter by 8 ft. long, with a slope of 1 in. per foot. The trommel revolves at a speed of 36 r.p.m. The oversize is returned by a bucket elevator to each roll. The rolls average 185 tons per 24 hr., and have shown by test that 250 tons per hour can be maintained. The rolls are driven by two 75-hp. and one 100-hp. motors with a total load of 210 hp., or an average of 16 hp. per roll, including the oversize return elevator.

THE CONCENTRATION SYSTEM

The mill is divided into four sections after crushing the ore, an equal tonnage being treated in each section. The mill building is built on a level site and it is necessary to elevate and pump the various products for treatment. All line shafts are near the basement floor, together with the rolls and other heavy machinery, set on concrete foundations. The undersize from the 9-mm. trommels is conveyed to elevators and water added to sluice the ore into the boots. The elevators are 53-ft. centers, using 8 by 16-in. buckets with a belt speed of 400 ft. per minute. The discharge from the elevators is screened on 2-mm. screens.

The screens are of the Ferraris shaking type, first used by the Desloge Lead Co. in this district, but have been redesigned at Bonne Terre to withstand the service required and to fit the limited head room. The screens are made at the plant, and cost about $125 each, erected. Three screens are used at each elevator, driven separately from a line shaft, so that repairs can be made, or screen sheets changed, while the other two carry the load. The screen frame is supported by hickory hangers set at an angle of 65 deg. to the frame. The drive-rod is connected to the head of the screen and a jig eccentric on a countershaft over the screen supports. The eccentric is set for 1¼-in. stroke and a speed of 270 to 290 r.p.m. A clear-water spray is used over the screen near the center to wash the fines from the oversize. Various screen openings have been tried, but at present 2-mm. round holes in No. 18 gage sheets are used, the sheets lasting about 40 days. Each screen treats 250 to 300 tons per 24 hours and requires 0.75 hp.

THE JIG INSTALLATION

The Hancock jigs treat the oversize of the 2-mm. screens. They are divided into five hutches and a tail compartment. The first and second hutches produce

concentrates, sent to the recleaning system. The third hutch is arranged for sending its product either to the concentrates or the middlings. The fourth and fifth hutches produce middlings. The camshaft has a speed of 65 r.p.m., giving the jig 195 strokes per minute. The horizontal throw averages ¾ in. and the vertical throw about ⅝ in. The tailings are dewatered by drag scrapers in the last compartments in order to separate them from the slimy water that overflows the jig and goes to the Dorr thickeners. The jig tailings are then sluiced to concrete tanks and dewatered by shovel wheels, the discharge going to a belt conveyor and concrete bin. These shovel wheels are 14 ft. in diameter, and make 1 r.p.m., the discharge averaging 15 per cent moisture.

The third and fourth hutch middlings are dewatered by a shovel wheel and recrushed by rolls, returning to the jig elevator and 2-mm. screens. These middlings are crushed to an average of 3 mm., releasing the galena in as coarse a size as possible.

THE BALL MILLS IN USE

A 6 ft. by 22 in. Hardinge mill crushes the middlings in section 1, and a 6 by 4 ft. Allis-Chalmers granulator is installed in section 3. They are being tested for results before placing mills in the other two sections.

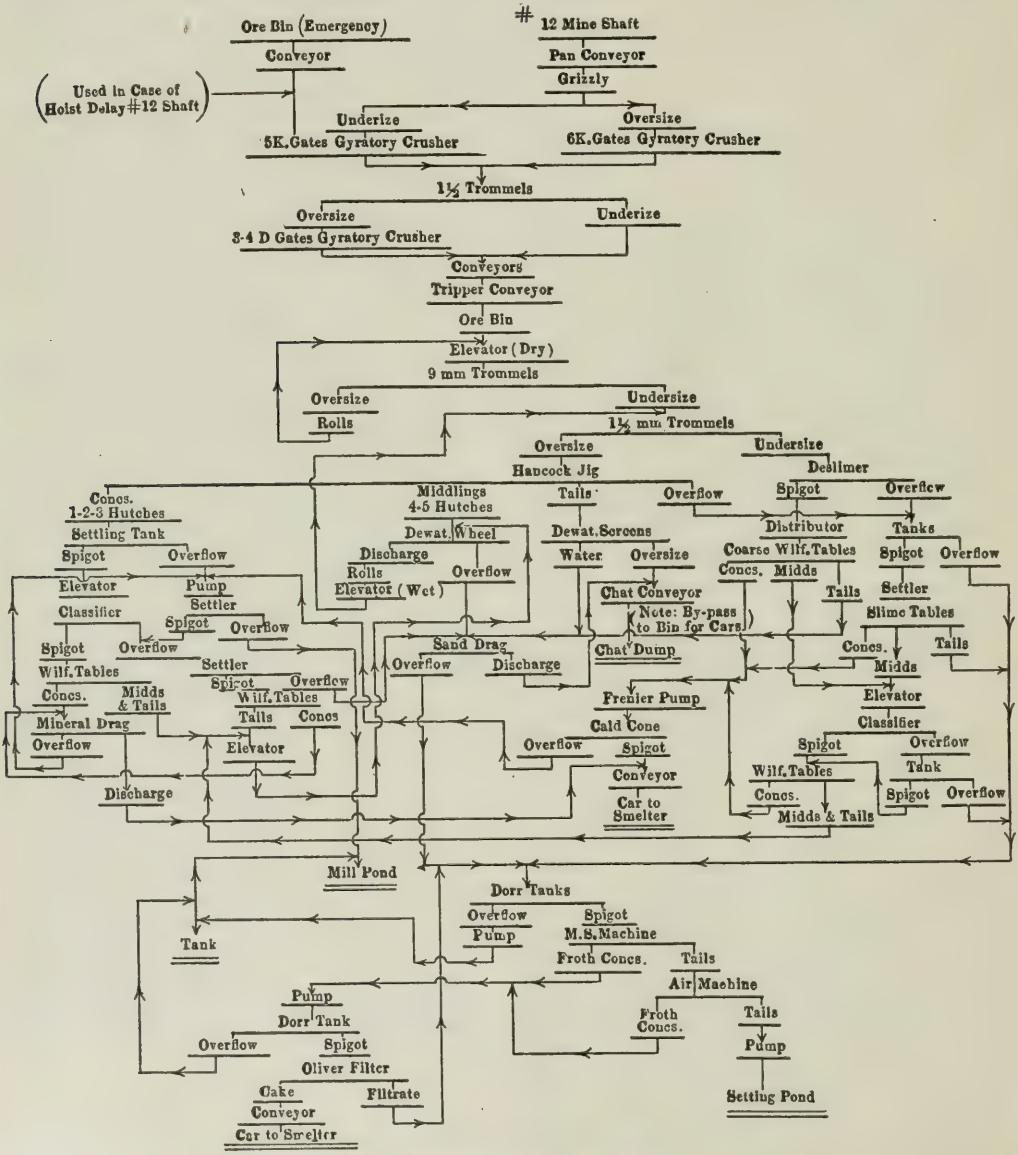

FIG. 3—LEADWOOD MILL FLOW SHEET

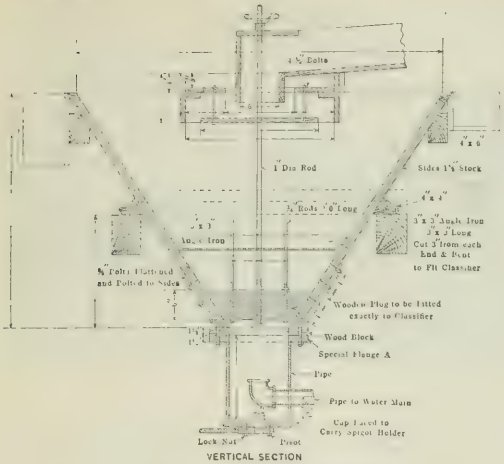

FIG. 4—THE DELANO DESLIMER

As final results had not been worked out on either type of mill at the time of writing, it is possible to give only some of the experimental data at present, showing the grinding efficiency and tonnages treated by each mill.

Results with the Hardinge mill are shown in Table 3.

TABLE 3—*Data on Hardinge Mill Operation*

Average tonnage ground	250 tons per 24 hr. (this includes 50 tons of middlings returned from table treatment).
Ball load	14,000 lb.
Kind of balls	Cast iron, with 3 in. maximum diameter.
Power required	53 hp.
Speed of mill	30 r.p.m.
Moisture	50 per cent.
Ball consumption	0.9 lb. per ton crushed

The following screen analysis in Table 4 shows the crushing performed on this class of material.

The discharge from the mill is screened through a 2-mm. shaking screen. The oversize returns to the jig elevator as jig feed, and the undersize is pumped to a deslimer for table and flotation treatment.

Various tests have been tried in crushing by the Hardinge mill, *e.g.*, crushing the entire middlings, returning the oversize to the jig and the undersize to tables and flotation. This method enriched the flotation feed too much, due to the rich middlings from the third and fourth hutches of the jig. Another test was to crush the entire tailings of the jig, the middlings being crushed in the rolls and returning to the elevator, and the oversize of tailings from the ball mill being discarded as chat. The ball mill lacked capacity to treat the necessary tonnage in this manner, and it was found that the most economical method was to crush the middlings from the fifth hutch of the jig. This gave low tailings on the jig and low-grade slime for flotation, besides allowing a larger tonnage of ore to be treated in the mill section.

THE ALLIS-CHALMERS GRANULATOR

This mill has a grate through which the crushed product must pass before being discharged. As with the Hardinge mill, various tests are being made to determine its crushing capacity, efficiency, etc. The first tests were to crush the jig tails, cast-iron balls with 3-in. maximum diameter being used as grinding mediums. Ball loads ranged from 9000 lb. to 14,000 lb., but the results were not satisfactory, the tonnage building up in the mill and choking it. Raising the pulp level improved the grinding slightly. It was found, however, that the balls broke up badly, so a change was made to forge chrome-steel balls of large diameter. Tests for ball charges, load and pulp level have resulted in gradually raising the tonnage of feed and grinding efficiency. The results shown in Table 5 are the best that have been obtained as yet, further tests being made with a closed circuit.

TABLE 4—SCREEN ANALYSIS OF HARDINGE MILL MATERIAL

Feed Mesh	Feed Per Cent Weight	Feed Cumulative, per Cent Weight	Product Mesh	Product Per Cent Weight	Product Cumulative, per Cent, Weight
On 3	5.34	5.34			
On 4	15.00	20.34	On 4	1.1	1.1
On 6	12.45	32.79	On 6	1.3	2.4
On 8	17.45	50.24	On 8	2.0	4.4
On 10	15.60	65.84	On 10	5.8	10.2
On 14	10.27	76.11	On 14	6.4	16.6
On 20	4.49	80.60	On 20	6.6	23.2
On 28	2.29	82.89	On 28	7.8	31.0
On 35	1.52	84.41	On 35	6.9	37.9
On 48	1.95	86.36	On 48	6.6	44.5
On 65	2.46	88.82	On 65	5.8	50.3
On 100	3.98	92.80	On 100	7.8	58.1
On 150	5.25	98.05	On 150	8.4	66.5
On 200	1.10	99.15	On 200	8.8	75.3
Through 200	0.85	00.0	Through 200	2.47	100.0
Total	100.00			100.00	

The discharge from the mill for a while was screened through a 2-mm. screen, the oversize being discarded as chat. Later a 3-mm. screen was substituted, resulting in the table tailings averaging practically the same as with the smaller opening. The oversize of this screen was also discarded, but is now being returned to the jig feed, making a closed circuit on the ball mill. Results from this at present are not complete.

TABLE 5—ALLIS-CHALMERS BALL GRANULATOR RESULTS

Character of feed	Jig tails and fifth-hutch middlings
Ball load	12,000 lb. (consisting of 100 lb. of 5 in. diam., 3000 lb. of 4 in. diam., 8000 lb. of 3 in. diam.)
Revolutions per minute	23
Grate opening	⅜ in.
Pulp-level distance from center	16 in.
Tons feed per 24 hr	486
Per cent moisture	62.6
Horsepower	59.4
Tons crushed through 2 mm. per horsepower	6.7
Oversize of 3-mm. screen discarded as chat.	

SCREEN ANALYSIS OF PRODUCT

Mesh	Per Cent Weight
On 10	18.7
On 150	62.7
Through 150	18.6
Total	100.0

SUMMARY OF BALL MILL PRACTICE

It is impossible now to give final results metallurgically as to the effect of ball mills on the milling practice of the ores. However, an increased capacity for the plant is obtained when the middlings are taken from their former closed circuit with the jig and recrushed in ball mills. The undersize of the ball-mill discharge is deslimed, the sands going to separate tables. This gives the jig capacity for more original ore, and the plant now handles 2300 to 2400 tons per day. This

FIG. 5—DOE RUN LEAD CO.'S MILL, RIVERMINES, MO.

alone has justified the installation of the ball mill. On the other hand, rolls cannot grind the low-grade middling as well as the ball mill, the latter giving more material for tables and flotation, which result in lower tailings than the jigs. The regrinding of jig tailings has resulted in lowering the final tailings. Approximately 60 per cent of the feed to the Allis-Chalmers ball mill is sent to tables, the tailings of which average less than 0.4 per cent Pb. The flotation plant receives 18 per cent of the feed and will make minimum tailings there. The tests have not been completed to show the economic effect of lowering the mill tailings, but the results point toward a profit, even with a low-price lead.

TABLE CONCENTRATION

In the summer of 1915, it was decided by the management to give the Butchart riffling a trial in table practice, in order to increase the tonnage and efficiency of the mills. A series of tests were carried out for several months at the Bonne Terre mill to determine the best application of the riffle to the treatment of these ores.

Previous to this time, Wilfley tables and riffling had been used, the feed to the tables being the spigot products of Richards four-spigot, vortex classifiers. The Butchart riffling worked best, however, with deslimed sands, no separation into different sizes being required. As it became necessary to mix the spigot products of the classifiers, it was decided to change the classification system.

Experiments were conducted to produce a one-spigot classifier that would handle the entire tonnage of the undersize from the 2-mm. shaking screens and deslime it so as to give a table feed practically free from the minus 150-mesh slimes. The experiments resulted in a one-spigot, two-product, hydraulic classifier, or deslimer, with an inverted conical or pyramidal tank, the entire perimeter being used for the overflow into a surrounding launder at the upper edge. The deslimer is provided with a central feed box, having a baffled bottom to break the velocity of the inflowing pulp. The bottom, or discharge chamber, has a clear-water inlet, which directs the flow upward along the axis of the deslimer. The spigot is inserted in a movable holder, attached to the bottom of the discharge chamber, permitting an instant change in the diameter of opening without wetting the operator. Between the feed box and discharge chamber is a valve with sides parallel to the tank and suspended on the vertical center, and which can be raised or lowered by means of a hand wheel on the suspension rod. This produces a narrow channel between the valve and tank through which the hydraulic water rises and the sands fall.

The feed entering the deslimer is checked by the baffle, causing the sands to settle through a narrow, rising current of water surrounding the valve. This current increases in velocity until the discharge chamber is reached, by which time the sands are thoroughly deslimed. A hydraulic pressure of 5 or 6 lb. per square inch is maintained in the discharge chamber. The width of the sorting column may be varied by raising or lowering the valve. No whirling or boiling currents are possible and the steady rising current gives a very close separation. The great efficiency of the deslimer is due to the better application and direction of hydraulic water supplied. A deslimer 5 ft. 6 in. in diameter treats from 350 to 400 tons per 24 hours, using approximately 120 gal. of hydraulic water per minute.

Table 6—Screen Analyses of Deslimer Material

Mesh	Feed, Per Cent Weight	Spigot, per Cent Weight	Overflow, per Cent Weight
On 100	64.70	86.8	0.69
On 150	7.41	8.2	5.16
On 200	4.10	2.3	9.32
Through 200	23.79	2.7	84.83
Total	100.00	100.00	100 00

Experiments with the Butchart riffling were carried out with the following objects in view, viz., to determine size and character of feed, to increase the table efficiency, increase its capacity, simplify the flow sheet, reduce water consumption, power and labor. Its ability to treat unclassified material gave it advantages over the Wilfley riffling by eliminating the multiple-spigot classifier. The concentrates are discharged at the upper edge of the table, the coarser particles being in the upper riffles instead of mixing with the middlings, as in the Wilfley riffling. This gives a larger capacity for both the concentrates and middlings separation and enables much larger tonnages to be treated per table.

Tests were made with feed ranging from minus 9 mm., or jig feed, to the finest sands. In each case the

FIG. 5—DOE RUN LEAD CO.'S MILL, RIVERMINES, MO.

riffling was made especially for the size of feed treated. The separation of free galena as concentrates in each case was satisfactory, but in the coarser sizes the separation of the middlings from the gangue was imperfect and would have necessitated recrushing the entire tailings for retreatment. Final tests showed that the jigs gave a better separation of tailings and middlings on material from 9 to 2 mm., while the undersize of 2-mm. screens deslimed to remove the minus 150-mesh slimes, and treated on tables, gave satisfactory results.

With this size of feed the tables now treat from 50 to 60 tons per day, giving clean concentrates and as low tailings as with the Wilfley when treating 20 to 25 tons per day. In operation, the table requires very little adjustment, even with the load varying 5 or 10 tons. The riffling used in this work tapers from 7/16 in. to ⅛ in., with a slope of 1 in 4 in the cleaning zone. The middlings average approximately 10 per cent of the feed to the tables. This is retreated on a separate table for two mill sections, the tailings being reground in the 6-ft. ball mill. A concentrate cut is made from this table and the middlings are reground in a 3-ft. Hardinge mill and sent to another circuit.

In changing the mill from the Wilfley to the Butchart system, one Butchart table replaced three Wilfley tables, and resulted in a saving in power, labor and water. Various pumps, launders, classifiers and settling tanks were also cut out, making a much simpler flow sheet in this mill.

The possibility of using the Butchart riffling to raise the grade of the mill concentrates was suggested by its large capacity and its ability to treat coarse material, discharging the coarsest particles at the upper edge of the table. The jig concentrates were erratic, ranging from 60 to 70 per cent Pb, and occasionally going lower. Before this they had been washed in a log washer or trunking machine, which made a rather poor separation. Tests with the Butchart riffling showed that the feed should be deslimed and treated on two tables. The spigot of the deslimer—or plus 100-mesh material—was treated on one table, and the overflow, or minus 100-mesh material, was settled in a tank, the spigot feeding the second table.

Table concentrates were mixed with the jig concentrates to produce a mixture of sizes that would bed well on the table. The riffling on each table was especially arranged for the size and character of the feed. The coarse galena was discharged in the upper riffles, followed by the finer sizes. A good separation was made in the cleaning zone, the tailings constituting true middlings containing practically no free galena. They averaged 25 to 35 per cent, and are recrushed in the jig-middling rolls, returning to the circuit by the jig elevator. The coarse table now treats from 70 to 100 tons per day and has capacity for a larger range in tonnage.

The fine-table concentrates averaged 80 per cent Pb, 95 per cent passing a 200-mesh screen. The tailings average 6 per cent Pb, and are returned to the sand middlings table.

At present the entire jig concentrates and a portion of those from the tables are treated in the recleaning system. The grade of the mill concentrates has been raised from an average of 68 per cent to 73.5 per cent, resulting in smaller freight and smelter treatment charges, and without affecting the mill recovery.

CONCENTRATES DISPOSAL

The concentrates from the entire mill are sent to a 60-ft. Allen cone for dewatering. The spigot discharges on a conveyor belt to the car, while the overflow returns to the mineral elevator.

The jig-tailings disposal was referred to in describing the jigging. The tailings from the tables are dewatered by Caldecott cones, the sands discharging through the spigot to the chat conveyor. The cones will average from 400 to 500 tons of minus 2-mm. sands per day, the average moisture in spigot being 28 per

FIG. 6—FLOTATION MACHINE, RIVERMINES MILL

FIG. 7—ST. JOSEPH LEAD CO.'S BONNE TERRE PLANT

cent. A screen analysis of the spigot discharge is shown in Table 7.

TABLE 7 -CALDECOTT CONE SPIGOT DISCHARGE

Mesh	Per Cent. Weight	Mesh	Per Cent. Weight
+10	2.59	+65	7.27
+14	9.61	+100	6.65
+20	17.64	+150	5.18
+28	22.95	+200	1.25
+35	15.13	−200	0.86
+48	10.87		
		Total	100.00

The sands from these cones, and the shovel-wheel discharge, or jig tailings, are conveyed by a 20-in. conveyor to a concrete chat bin with a capacity of 250 tons. Railroad cars of the A-dump type run under this bin, and are loaded by slide gates in the bottom of the bin, and sent to the chat dump. A portion is sold for railroad ballasting and concrete work.

THE PYRITES CONCENTRATES

The ore assays approximately 5 per cent Fe, consisting mainly of pyrite, marcasite and chalcopyrite. This is concentrated in the table middlings and requires fine grinding to separate the galena, pyrite and dolomite. The middlings from the sand tables are reconcentrated on a middling table and the middlings from this table are sent to a 3-ft. Hardinge mill for regrinding. The mill is operated with a 1000-lb. ball load, replenished with 2-in. cast-iron balls. The product will nearly all pass a 65-mesh screen, and is elevated to a Butchart table. Lead concentrates, assaying 80 per cent, are sent to the Allen cone and middlings are retreated on another Butchart table, which produces galena-pyrites concentrates. The analysis of concentrates shows an average of 41 per cent sulphur, a portion being shipped to a sulphuric-acid plant for experimental purposes, with a view to recovering the sulphur as acid. The remainder is mixed with the galena concentrates and is shipped to the St. Joseph Lead Co.'s smeltery at Herculaneum for its value as an iron flux.

TREATMENT OF SLIMES

The overflow of the deslimers, chat-wheel pits, Caldecott cones and various small settling boxes, is thickened in five Dorr tanks, four of which are 40 by 8 ft., and one 50 by 6 ft. The feed to these tanks averages 2.5 per cent solids, the total flow being approximately 3500 gal. per minute. The solids average 540 tons per 24 hours, or approximately 12 sq. ft. of settling area per ton of dry slime. The central shafts revolves once in 10 min. The overflow from the tanks returns to the

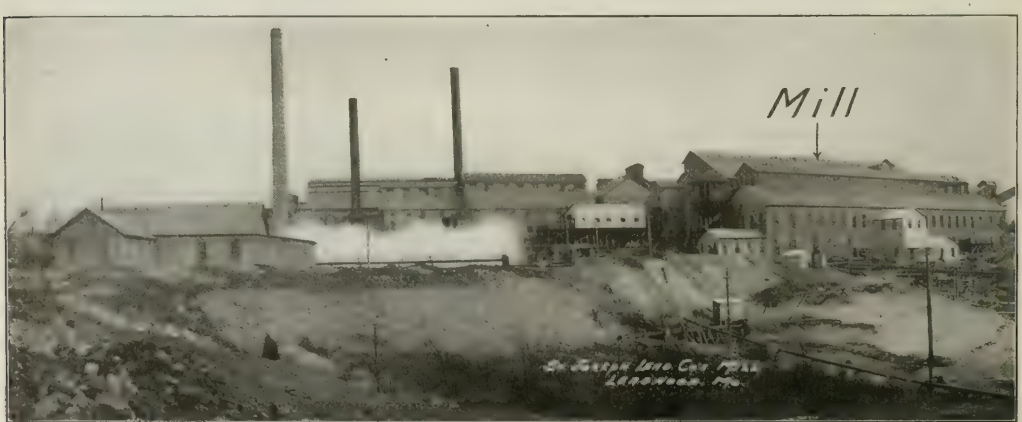

FIG. 8—ST. JOSEPH LEAD CO.'S MILL, LEADWOOD, MO.

mill pond for use as mill wash water, while the spigot discharge is sent to the flotation machine.

The thickened pulp at a ratio of 2.5 to 3.0:1 is treated in a 23-cell Minerals Separation flotation machine, with 24-in. agitating compartments. Creosote oil (hardwood) is added in the feed box and at several alternate cells, a small oil pump being used to give a regular oil feed. The impellors are belt driven from a line shaft, the speed being 335 r.p.m.

The machine is driven by a 100-hp. motor using 83 hp., or an average of 3.8 hp. per cell. The tailings from this machine are retreated in a pneumatic machine. The froth, or concentrates, averaging 50 per cent Pb from both machines, are elevated by a bucket elevator to a Dorr thickener.

Oil consumption averages 0.55 lb. per ton of dry slimes treated. The slimes average 540 tons per day, or, at present, 23 per cent of the ore milled. This percentage is higher than in the other mills of the company, due principally to the use of Cornish rolls and the larger proportion of reground middlings.

CONCENTRATES DISPOSAL

The froth is broken up by clear-water sprays and thickened in a 38 by 6-ft. Dorr tank. The overflow goes to the slimes tanks and the spigot discharge, averaging 60 per cent solids, is sent to a 12-ft. by 11-ft. 6-in. Oliver filter. The Dorr-thickener feed averages 90 per cent moisture. A permanent froth remains on the surface and is kept from overflowing by a baffle ring 12 in. inside the overflow and 12 in. above and below the surface of the water. The central shaft revolves twice per hour.

The cake from the Oliver filter averages 15 per cent moisture, and is conveyed by belt conveyor to cars and shipped to the smelter. At present a portion of this cake is dried in vats fitted with steam coils, to a moisture of 7 per cent, in order to enable the smelter to handle the output. The filtrate returns to the slimes thickeners. The filter speed is one revolution in 6 min. and 30 sec. The wet cake averages approximately 50 tons per 24 hours. One "blow" compartment is maintained about 6 in. above the scraper, the other compartment blowing after immersion in the pulp, which is kept at a maximum level. The blow pressure ranges from 5 to 10 lb. The vacuum is produced by a No. 5 Root pump, averaging 25 to 20 in. The vacuum requires 29.5 hp. and the filter 1.7 hp. The life of a canvas and burlap averages 3 months. After a new canvas is in use from 4 to 6 weeks, steam is exhausted in the pulp for the purpose of heating. This gives a larger capacity without increasing the moisture in the cake. Acid washes have been tried for the canvas without success.

The tailings from the flotation machines are pumped by a 3-in. Morris sand-dredge pump to the impounding pond, against a total head of 50 ft., using 18 hp. The pond dam is built of chat hauled from the mill and is 50 ft. high at its maximum point. The flow of pulp averages 225 gal. per minute, and immediately spreads over the surface of the pond, allowing the solids to settle rapidly. No water remains on the surface, as it filters rapidly through the chat dam. Consequently the pond will eventually fill up in layers, forming a smooth dry body of compact slime. The filtered water is perfectly clear and free from slime.

The mill water is returned to a pond with an area of 17,000 sq. ft., formerly used for settling the mill slimes before the installation of Dorr tanks. Any slimes now escaping the Dorr tanks are caught in this pond and pumped back periodically for retreatment. The volume of water used in the mill circuit is approximately 3500 gal. per minute, or a ratio of 9:1. This compares with a ratio of 17:1 before the change was made in table practice, classification, etc. Loss in mill water, due to waste of flotation tailings, etc., is made up of mine water and from a pumping station on Big River, 3 miles away.

All machinery in the mill is electrically driven, using an average of 7.29 kw. per ton of ore treated. With the present tonnage treated this equals approximately 925 hp. As much machinery as possible is driven by individual motors, even some of the tables using separate 1-hp. motors. All motors are loaded to capacity to obtain greatest efficiency.

The labor in the mill is all American and much more efficient than a few years ago. The tons of ore milled for 1916 averaged 25 per man shift, including maintenance, with an average of 84 men employed per day. Three shifts are operated per day, 6 days a week, Sundays

FIG. 8—ST. JOSEPH LEAD CO.'S MILL, LEADWOOD, MO.

being used for repairs. The mill recovery varies with the grade of ore, the tailings from the plant being equal to the district average. Future improvements will probably include larger crushers, substitution of other grinding machinery for the Cornish rolls, and extension of table and flotation equipment, with the view of raising the tonnage, recovery, and the cheapening of costs.

THE RIVERMINES MILL

The Rivermines mill is divided into six sections. The ore is crushed to 4 in. at the mine shafts and hauled in A-dump cars by railroad to a large storage bin extending across the mill end. This bin has a capacity of 3500 tons or sufficient for nearly a day's run. A trestle extends beyond the bin, so that the cars may be pinched down grade over the bin and emptied. In winter, steam nozzles are used to thaw the ore sufficiently for unloading. All the ore is weighed on scales on this trestle.

The ore is fed from the bin by roller feeders, operated by a gripping cam, to 1-in. round-hole trommels, 8 ft. long by 24 in. in diameter. The oversize of these trommels is crushed by two No. 3 McCully gyratory crushers, the crusher discharge joining the undersize from the trommels and is carried by belt conveyor to two 48-in. by 12-ft. trommels with 9-mm. round holes. The oversize from these trommels is recrushed by rolls. The discharge from the rolls returns to the conveyor feeding the 9-mm. trommels, the undersize of which goes to an elevator, which raises the dry ore to the 2-mm. trommels on the top floor. From this point the milling practice is practically the same as at the Bonne Terre mill.

THE MARCY MILL

An 8 by 6-ft. Marcy ball mill has been installed in section 5 for experimental purposes. This mill has been tried in various tests and is now crushing the oversize from the 9-mm. trommels and the dewatered middlings from the fourth and fifth hutches of the Hancock jig. The discharge from the ball mill goes to the 2-mm. trommels, the oversize feeding the jig and the undersize the tables and flotation plant. As in the Bonne Terre mill, final results have not been worked out on this mill. As it is a grate-type mill, the results are similar to those of the Allis-Chalmers granulator. In this case 73 per cent of the feed to the mill is the oversize of the 9-mm. trommels, the balance being middlings from the jigs and tables, the total averaging 750 tons per day. Approximately 200 hp. is required, the mill using a ball load of 28,000 lb. of 5, 4 and 3-in. balls; 5-in. balls being used for replenishing. The average moisture is 65 per cent. Screen analyses of the feed and discharge product are shown in Table 8.

The jig tailings are dewatered in chat wheels as at Bonne Terre, and the table tailings in sand cones and a sand drag. They are then stacked by belt conveyors, forming a very large tailings pile, which has accumulated since the plant started.

The tailings from the flotation plant are pumped by a 5-in. Morris sand-dredge pump to the top of the chat pile and is used for spreading the chat from the conveyors.

The mill water is settled in a pond back of the plant and is pumped from there to a reservoir situated at a maximum elevation in front of the building, from which it is reused in the mill circuits. The volume of water used is approximately 5000 gal. per minute, or a ratio of 7:1 of ore.

Table 8—Marcy Mill Results

Feed				Discharge			
Mesh On	Per Cent. Weight	Cumulative per Cent. Weight	Per Cent Total Pb Content	Mesh On	Per Cent. Weight	Cumulative per Cent. Weight	Per Cent Total Pb Content
1¾ in.	27.7	27.7	27.1	3 mm.	20.1	20.1	5.2
9 mm.	41.3	79.0	44.5	2 mm.	9.1	29.2	3.6
3 mm.	14.1	83.1	16.5	20	21.9	51.1	10.0
2 mm.	7.8	90.9	3.4	28	8.4	59.5	6.8
20	4.4	95 3	1.5	35	5 7	65.2	5.5
35	2.0	97.3	1.5	48	5.2	70.4	7.7
65	0.9	98 2	1.2	65	4.0	74 4	6 8
150	0.8	99.0	1.2	100	3.9	78 3	7.7
−150	1.0	100.0	3.1	150	4.0	82.3	9.0
				200	3.0	85.3	6.1
Total..	100.0	.....	100.0	−200	14.7	100.0	31.6
				Total....	100.0	.. ....	100.0

All power is alternating current, an average of 8.24 kw. is used per ton of ore treated. The labor is all American. This mill will be rearranged later with ball mills for reducing the general tailings and increasing the capacity.

THE LEADWOOD MILL

The Leadwood mill has practically the same milling operations as at the Bonne Terre and Rivermines plants. All the ore is hoisted from No. 12 mine shaft at the mill and is conveyed direct to the crushers. In case the hoist should be out of commission for any reason, the ore from the outlying shafts can be diverted to an ore bin from which it is conveyed to the 5 K Gates crusher, thus preventing an entire shutdown of the mill.

The regular ore feed is screened on a grizzly with bars spaced 8 in. apart. The undersize is crushed in the 5 K crusher and the oversize in the 6 K crusher. The discharge from these crushers is screened through 1½-in. trommels, the oversize being recrushed in three No. 5 D Gates crushers. From here it is conveyed to an ore bin of 1600 tons capacity, and distributed by a tripper on the conveyor.

The ore from the bin is screened through 9-mm. trommels. The oversize is recrushed by rolls and returned to the 9-mm. screens. The undersize is screened through 1½-mm. trommels. From this point the concentration is practically the same as at Bonne Terre and Rivermines.

The jig tailings discharge in the bottom of the tail hutch of the jig and fall over stationary 1½-mm. screens. The oversize discharges on the chat conveyor, while the water drains to the sand drag. Wilfley tables, a portion Butchart riffled, are used for sand concentration. The minus 1½-mm. and plus 150-mesh sands are treated on the coarse tables, the tailings going to a concentrates pit. A drag scraper in this pit dewaters the sands and discharges them on the chat belt with 15 per cent moisture. This drag gives some trouble by breaking, but manganese-steel link chains are now being used in order to reduce this to a minimum.

The fine sands, minus 150-mesh, and slimes are thickened in settlers and concentrated on Wilfley tables, the tailings going to the Dorr tanks at the flotation plant. The overflow of the sand drag also goes to the flotation plant. The slimes are thickened in four 36 by 8-ft.

Dorr thickeners. The pulp is agitated in a 16-cell Minerals Separation flotation machine, the same oil being used as at the other mills. The tailings are retreated by an air machine, and the concentrates are thickened and filtered by an Oliver filter. The flotation plant is lightly loaded, approximately 350 tons dry slimes, and the concentrates produced average 58 per cent Pb. The slime tailings are pumped to a settling pond behind the chat dump and settle as at Bonne Terre.

The mill chat, jig and table tailings are conveyed by belt conveyor to a tailings pile. This conveyor inclines at an angle of 26 deg. and the chat is sufficiently dry not to cause any slippage on the belt, which is not cupped.

This mill will be equipped with ball mills for regrinding middlings and tailings as at Bonne Terre. A 6 by 4-ft. Allis-Chalmers ball granulator is installed in one section, but has not started operating, so no data can be given. A 3-ft. Hardinge mill is installed for regrinding table middlings as at Bonne Terre, but is just starting operation, and no results are obtainable. The Leadwood ores contain considerable zinc sulphides, which will probably concentrate in this circuit.

The milling practice of the St. Joseph Lead Co. is passing through a transitory stage. Considerable experimental work is being done at each plant, a thoroughly equipped laboratory being maintained at each mill. While large tonnages are being treated in the three plants with the highest recoveries obtainable, it is probable that the introduction of ball mills and further extension of flotation equipment will greatly change the present practice.

Bonne Terre, Mo.

Motion Pictures at the Exposition

MONDAY, SEPT. 24

Evening—8.00 p. m.

1. Hydraulic power development (4 reels).
2. Making a giant steam turbine (General Electric Co., 1 reel).
   (a) Handling pig iron.
   (b) Filling the cupola and pouring castings.
   (c) Machining and assembling the castings.
3. Generation of electric power (2 reels).
4. Transmission of electric power (1 reel).
5. The fixation of atmospheric nitrogen by electricity at Niagara Falls and feeding the soil with the products (American Cyanamid Co. 2 reels).
6. The king of the rails, or the evolution of transportation (General Electric Co., 3 reels).

TUESDAY, SEPT. 25

Afternoon—2 p. m.

1. Carpet weaving (1 reel).
2. Manufacture and use of wool and its products (2 reels).
3. Cotton as a source of wealth—growing and manufacturing its products (3 reels).
4. The manufacture of leather and its products (1 reel).
   (a) Tanning.
   (b) Working up leather.
   (c) Manufacturing of shoes.
5. The manufacture of glass (3 reels).

Evening—

Production of spelter and manufacture of lead products (5 reels and stereopticons showing eighteen months' development).

(a) Mining zinc and lead ore in Oklahoma.
(b) Smelting for lead and zinc at Joplin and Henrietta.
(c) Production of sublimed lead pigment from the ore by the fume process.
(d) Manufacture of carbonate of lead for paint pigment.
(e) Manufacture of lead paints, accompanied by descriptive discussion by John R. MacGregor, assistant general sales manager Eagle-Picher Lead Co.

WEDNESDAY, SEPT. 26

Afternoon—2 p. m.

1. Manufacture of linen bond paper (1 reel).
2. The cordage industry (5 reels).
3. Manufacture of paint (3 reels).
4. The soap industry (1 reel).
5. The manufacture of perfumes "The Spirit of the Flowers" (1 reel).
6. Industrial plants on the Clinchfield Railway.

Evening—

1. The coal, coke and by-products industry (The Barrett Co., 2 reels).
   (a) Coal mining operations.
   (b) Old and new methods of coking coal.
   (c) Recovery of by-products.
   (d) Use and results from ammonium sulphate as a fertilizer.
2. The asphalt industry (Barber Asphalt Paving Co.).
   (a) Removing asphalt from Trinidad and Bermudez Lakes.
   (b) Transportation of raw asphalt.
   (c) Refining and manufacturing.
   (d) Building roads and streets.
   (e) Manufacture of prepared roofings and other products.
3. The petroleum industry—shooting the Lake View Gusher.

THURSDAY, SEPT. 27

Evening—The metal industries—

1. Copper leaching operations at the plant of the Chile Exploration Co., Chiquimata, Chile. (4 reels).
2. Silver—"The Treasure of the Incas" (2 reels).
3. Gold—"The Basis of Business" (1 reel).

FRIDAY, SEPT. 28

Afternoon—2 p. m.

1. Asbestos as fire protection (1 reel).
2. Building of roads and their maintenance (DuPont de Nemours Co., 2 reels).
3. Farming with dynamite (DuPont de Nemours Co., 1 reel).

SATURDAY, SEPT. 29

Afternoon—2 p. m.

1. The manufacture of Portland cement (1 reel).
2. Triumph of the ultramicroscope—seeing invisible colloid particles (1 reel).
3. The milk industry (2 reels).
4. Preparation of condensed milk (3 reels).

Evening—8 p. m.

1. The sugar industry (4 reels).
2. The flour industry (2 reels).

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5.—Chemical News
6.—Chemiker Zeitung
7.—Chemische Industrie
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10.—Gazetta chimica italiana
11.—Génie Civil
12.—Journal of the American Chemical Society
13.—Journal of the Chemical Society of London, Proceedings
14.—Journal of the Chemical Society of London, Transactions
15.—Journal of the Franklin Institute
16.—Journal of Industrial and Engineering Chemistry
17.—Journal of the Physical and Chemical Society of Russia
18.—Journal of the Society of Chemical Industry
19.—METALLURGICAL AND CHEMICAL ENGINEERING
20.—Pharmaceutical Journal
21.—Philosophical Magazine (The London, Edinburgh and Dublin)
22.—Philosophical Transactions of the Royal Society
23.—Proceedings of the Royal Society
24.—Receuil des travaux chimiques des Pays-Bas et de la Belgique
25.—Science Abstracts
26.—Transactions, American Electrochemical Society
27.—Zeitschrift fur angewandte Chemie
28.—Zeitschrift für anorganische Chemie
29.—Zeitschrift für Elektrochemie
30.—Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandtschaftslehre

Part II. British, German, American and French Patents

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Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	Others
1902						
PAULING, H., Brandau (Austria) Process of mfr HNO_3 from air	.....	.....	807,491	323,760	22-495	.....
WEST DEUTSCHE THOMASPHOSPHATWERKE Process for the mfr of NH_3 synthetically by means of dark electric discharges	.....	179,300	.....	.....	.....	27-20-1065 7-1906-657
Process for the production of N peroxide and HNO_3 from N and O at high temperatures containing free N and O.	.....	182,297 194,326	.....	.....	.....	27-20-1376 27-21-797
Process for the production of N-O cpds by the action of electric discharges upon air or other gas mixtures containing free N and O.						
WOLTERECK, H. C., London Synthetic mfr of NH_3	.....	146,712	.....	.....	.....	27-16-1160 7-1903-600
1903						
BAYER, FRIEDRICH, & CO., Farbenfabriken, Elberfeld Production of nitrous anhydride and salts of HNO_2	15,594	168,272	.....	335,229	23-186	6-29-531
EYDE, S., and BIRKELAND, K. Process for the production of intense chemical reactions in gaseous mixtures	.....	.....	.....	335,692	23-193	.....
KOWALSKI, J. V., and MOSCICKI, I., Fribourg Electric plant for the synthetical production of nitric products by discharges of electricity in gaseous mixtures	20,497	.....	.....	.....	22-1297	.....
NAVILLE, A. A., GUYE, P.-A., and GUYE, C.-E. Self-regulating apparatus for submitting gases and vapors to the action of the electric arc	.....	187,585	.....	350,120	.....	.....
OSTWALD, W., Leipzig Process for mfr of HNO_3 from NH_3	698	.....	.....	.....	.....	6-27-467
PAULING, H., Brandau (Austria-Hungary) Apparatus for treating gases	.....	.....	739,920	.....	22-1135	.....
Apparatus for treating gases	.....	.....	739,921	.....	22-1135	.....
SIEMENS UND HALSKE AKTIEN. GES. Electric production of oxides of N	.....	.....	.....	335,453	23-193	.....
SOC. ANON D'ÉTUDES ELECTROCHIMIQUES, Geneves. Apparatus for the treatment of gases or vapors with electric flame arcs under application of horse-shaped or similarly shaped electrodes the distance between which increasing with height.	.....	187,585	.....	.....	.....	27-21-557
1904						
AKTIESELSKABET DET NORSKE KVAELSTOF-KOMP. Furnace for treating gases with a disc-shaped electrical flame expanded by a magnet in a narrow furnace space	.....	170,585	.....	.....	.....	27-20-324
Process for the treatment of gases in a magnetic field with electrical discharges under application of an alternating current	.....	188,231	.....	.....	.....	27-21-558
BADISCHE ANILIN- UND SODA-FABRIK Improvements in, and apparatus for, producing reactions in gases by means of electricity	5,688	.....	.....	.....	24-201	.....
Electric furnace for carrying out gas reactions by means of electric flame arcs	26,602	24,992 168,601	.....	350,392	24-1178	29-13-214
BIRKELAND, K., and EYDE, S., Christiania Improved process and furnace for subjecting solid materials to the action of the electric arc	20,003	.....	.....	.....	24-34	6-1904-997
BIRKELAND, KRISTIAN Process of electrically treating gases (air)	.....	.....	772,862	.....	23-1097	.....
Apparatus for electrically treating gases	.....	.....	775,123	.....	.....	.....
EYDE, S., Christiania (Norway) Improved process for the production of nitrites	28,613	.....	.....	.....	24-619	.....
Production of pure nitrates from mixtures of nitrates and nitrites	28,614	.....	.....	.....	24-619	.....
HELBIG, D. Process for the production of N-O cpds from atmospheric air or other gas mixtures containing N and O by means of the electric arc	.....	189,864	.....	.....	.....	27-21-556
KAISER, C. Mfr of NH_3	.....	181,657	.....	350,966	.....	27-1905-1762
KÄLER, H. v. Assignor to Farbenfabriken, Elberfeld Process of making nitrous anhydride and nitrites	.....	763,491	.....	.....	23-787	.....
KOWALSKI, J. v., and MOSCICKI, IG. Apparatus for electrical production of N or other cpds	.....	754,147	.....	.....	.....	.....
NEUBURGER, A., Berlin Process of oxidising atmospheric N	.....	.....	850,392	.....	.....	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	Others
1904						
PAULING, H. Gelsenkirchen						
Apparatus for the treatment of gases	.....	.....	758,775	.....	.....	.....
Process of mfr NO_2 and HNO_3	.....	.....	758,774	326,244	23-545	.....
Process of heating air	.....	.....	777,485	.....	.....	.....
Process of mfr HNO_3	.....	.....	777,486	.....	.....	.....
Process of making HNO_3 from air	5,540	.....	814,917	.....	.....	29-13-280
PETERSON, A. J., Alby (Sweden)						
Method of, and apparatus for, treating gases and gas mixtures by means of voltaic arcs	.....	.....	880,037	349,227	24-679	.....
			880,464			
Process and apparatus for carrying out chemical reactions in gases and gas mixtures by means of electric arcs between electrodes (kept a comparatively great distance apart)	...	185,897	.....	.....	.....	27-21-557
SALPETERSAURE-INDUSTRIE GESELLSCHAFT, Gelsenkirchen						
Process for the treatment of O, containing gas mixtures with the electric flame arc, carbon electrode being used		184,958		.....	.....	27-21-558
SOC. ANON. D'ETUDES ELECTROCHIMIQUES						
Apparatus operating with automatic regulation for submitting gases or vapors to the action of the electric arc	13,952			350,120	24-550	
WESTDEUTSCHE THOMASPHOSPHAT-WERKE, G.M.B.H.						
Electrical process for the mfr of HNO_3 and its cpds	25,010			348,189	24-441	.....
1905						
BIRKELAND, K., Christiania						
Apparatus for producing electric reactions in gases by aid of electric arcs	3,525				24-895	27-1905-1848
HELBIG, D., Rome (Italy)						
Oxidation of N by means of electricity			887,326	352,090	24-896	....
MARQUARDT, E., and VIERTEL, H						
Means for producing oxides of N	.....		804,021		.....	.....
MOSCICKI, J						
Device for production of N oxides by means of the alternating-current flame arc				33,694		29-13-241
						27-19-980
NAVILLE, A. A., GUYE, C.-E., and GUYE, P.-A						
Production of chemical reactions in gases at the temperature of the electric arc	21,338			361,827	26-23	
Process and arrangement for the production of chemical reactions in gases at the temperature of the arc.	21,338			361,827	26-209	
Process for carrying out endothermic gas reactions		210,821		361,827		27-22-1468
PAULING, H						
Production of HNO_3	7,871		807,491			27-19-1104
SALPETERSAUREINDUSTRIE-GESELLSCHAFT, Gelsenkirchen						
Process for treating gases with the electric arc, while solid conducting bodies are passed at regular time intervals between stationary electrodes		190,691				27-20-1328
Apparatus for carrying out the process for the production of HNO_3 or the like from air or other gas mixtures		187,367				
SERPEK, O						7-1907-158
Process for the mfr of Al-N cpds		181,991				27-20-1376
STUART, BAILEY C						
Mfr of $NaNO_3$ and the recovery of by-products in connection therewith	19,189				25-1044	29-1907-137
THORESEN, J. and THARALDSEN, F						
Process for the deviation of arcs or electric discharges, and apparatus for the decomposition and combination of gases, for example, of air, by means of these deviated arcs or discharges	13,689			352,556	24-976	....
WESTDEUTSCHE THOMASPHOSPHAT-WERKE G. M. B. H						
Process for the production of cpds of N and O by electric means				353,548	24-1013	....
1906						
AKTIESELSKABET DET NORSKE KVAELSTOFKOMPAGNI						
Furnace for treating gases with an electric flame spread out by a magnet to a disc in a small furnace space		179,825				27-20-1327
BORCHERS, W., and BECK, E						
Process for the preparation of nitrides from metallic oxides or salts, by means of atmospheric N		196,323			27-576	
BRISSET, G. J. J., and MUGNET, A. M.						
Electrochemical process and apparatus for mfr HNO_3 and other cpds by means of gases				375,349	26-930	.....
BRUHLER, O. H. U						
Apparatus for the oxidation of the N of the air for the purpose of obtaining HNO_3	5,852	185,094	834,257	363,617	25-846	
Utilization of the N of the air by the oxidation of the same, and conversion of the product into HNO_3 or the salts of HNO_3	5,901			363,618	25-811	
FERRANTI, S. Z. DE, Grindleford (Derby)						
Electric furnaces for the treatment of gases	13,965		898,346		26-1145	27-1908-554
GORBOFF, A., and MITKEVITCH, V						
Furnace for the production of oxides of N from air		196,114			27-576	.....
LOVEJOY, D. R. Assignor to Atmospheric Products Co.						
Method of effecting chemical action in gases			829,872		25-936	
Apparatus for subjecting gases to high-tension discharges			829,873		25-936	
Method of effecting the combustion of gases			829,874		25-936	
Apparatus for effecting chemical action in gases			829,875		25-936	
Process for effecting chemical action in gases			829,876			
Apparatus for effecting chemical action in gases			829,877			
MITCHELL, J. E., and PARKS, D.						
Apparatus for subjecting air to electric discharges			817,082			.....
MOSCICKI, J., Fribourg (Switzerland)						
Electric plant for producing chemical reactions	14,259				26-876	.....
Apparatus for the production of oxides of N by electric means	3,583			369,387	26-157	.....
Also Belgian Patent 201,874						
Apparatus for the production of N oxides by electrical process	27,006			380,614	27-22	.....
NORDYKE & MARMON CO., Indianapolis						
Catalytic apparatus (mfr of nitric oxide from NH_3)	1,204	189,472	.....	362,434	25-536	29-1907-625
OSTWALD, W						
Apparatus for moving and conveying hot N oxides		207,154	.....	...	28-365	.....
PAULING, H. Assignor to Salpetersäure-Industrie-Gesellschaft, Gelsenkirchen						
Process for the production of HNO_3 or nitric oxide from atmospheric air			873,891	365,070	25-928	.....
Process for concentrating HNO_3			887,266	368,716	26-24	.....
Electric furnaces for treating gases	8,452				25-1053	.....
Production of relatively long, strong-current voltaic arcs	7,869			374,278	25-935	29-13-228
Mode of obtaining gaseous endothermic reactions by the aid of voltaic arcs produced in O between fused metallic oxides	18,600			371,883	26-417	.....
Process for producing electric discharges	18,435			368,715	26-23	.....
Production of arcs for the electrical treatment of gases	18,599			368,717	26-23	29-13-226
Electrical production of pure HNO_3 from air	7,871				25-758	29-13-280
PLATSCH, M.						
Process for the preparation of oxides of N from gases containing N and O		200,138			27-940	

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	Others
1906						
SALPETERSÄURE-INDUSTRIE-GESELLSCHAFT						
Apparatus for the production of HNO_3 or nitric oxide from atmospheric air by means of the electric arc			186,454	.....	.....	27-21-558
Method for connecting high-tension flames in series in a high-voltage circuit for the purpose of inducing endothermic gas reactions			193,366	.....	.....	27-21-556
Electrolytic process for the concentration of HNO_3			18,082	.....	368,718	26-24
Production of electric arcs for the treatment of air or gases				374,238	26-766	.....
Process for producing HNO_3 or anhydride from atmospheric air				365,070	25-928	.....
Process for the production of HNO_3 or nitric oxide from atmospheric air			7,870	.....	.....	25-759
SCHERBIUS, A.						
Process for preventing decomposition of the reaction-products in chemical reactions between gases or mixtures of gases			213,709	.....	.....	28-1198
SERPEK, O						
Mfr of nitrogenized cpds of Al for production of NH_3			888,044	367,124	25-1096	.....
1907						
BENDER, O. Neu-Babelsberg						
Process and device for making cpds of O, HNO_3, H_2SO_4, etc.) from the elements at a high temperature			8,633	900,471	377,442	27-75
BRLDIG, G., and FRANKEL, W						
Mfr of cyanides, cyanamides and nitrides by means of N and metal carbides			202,795		382,188	27-225
CHEMISCHE FABRIK GRIESHEIM-ELEKTRON						
Manner of producing Pt contact substances and application to the production of HNO_3 from NH_3 and air			13,954		380,884	27-22
CYANID-GESELLSCHAFT M.B.H						
Mfr of N-cpds of the alkaline-earth metals by leading N over the corresponding carbides at a high temperature			200,305			27-1204
Mfr of nitrogenous cpds by means of carbides					382,743	27-251
DET NORSKE AKTIESELSKAB FOR ELEKTROKEMISK IND. and B. F. HALVORSEN						
Process for the absorption of weak nitrous fumes			16,885		380,190	26-1280
ELEKTROCHEMISCHE WERKE G.M.B.H.						
Process for obtaining N peroxide from mixtures of air and nitric oxide, containing only small quantities of the latter			9,233	199,561	383,281	27-856
FERRANTI, S. Z. DE						
Methods of, and means for, conducting gaseous endothermic reactions (N oxides from air)			20,097			27-1058
FRANK, A. R. Assignor to Soc. Generale Cianamide, Rome (Italy)				996,011		
Process of producing N cpds			21,786	987,674		27-898
				1,010,404		
Method of producing N cpds from carbides			3,314	1,006,927		27-749
Process for the preparation of HNO_3 from NH_3 by the contact process				224,329		29-1010
GES. F. STICKSTOFFDUNGER, WESTERGELN						
Process for the mfr of NH_3 (from cyanamides)			9,407		922,003	375,979	26-925
GUYE, P.-A.						
Preparation of nitrophosphates (recovery of oxides of N from mixtures of the same with air)					389,864	27-1032
HAUSSER, F., NURNBERG (Germany)						
Mfr of N oxides			27,826	216,518		29-25
HELBIG, R., Rome						
Process for oxidizing atmospheric N by electricity				926,413	385,193	27-576
KUNHEIM & Co						
Process for the sudden cooling of hot gases in endothermic and other reactions of gases and gaseous mixtures				205,774		28-243
MOSCICKI, Ig. Fribourg (Switzerland)						
Electric condenser				854,662		
Apparatus for the production of N oxides by electric means				933,094	380,614	27-22
NAVILLE, A. A., GUYE, P.-A., and GUYE, C.-E						
Process and apparatus for the recovery of oxides of N when mixed with air, by means of water			6,155		385,569	27-627
Recovery of oxides of N, when mixed with air or inert gases in the form of conc. HNO_3			6,366		385,605	27-627
NEUBURGER, A., and WESTDEUTSCHE THOMASPHOSPHATWERKE, Berlin						
Process for producing cpds of O and N			9,939		377,199	26-1907
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB						
Process for the absorption of nitrous vapors				206,949		28-385
PAULING, H						
Electric furnaces (Magnetic blower for producing two flame arcs of high tension directed downwards)			18,901		380,060	26-1243
Process for connecting in series, arcs of high tension with a high tension circuit			7,320		375,268	26-930
Electric furnaces and process for producing high-tension flame arcs			18,900		380,059	26-1204
RAMBAY, SIR W						
Recovery of oxides of N from air or other gases with which they are mixed			26,981			28-599
SALPETERSAUREINDUSTRIE-GESELLSCHAFT, Gelsenkirchen						
Process for the production of HNO_3 or nitric oxide from atmospheric air				193,402		....
SCHICK, K. Assignor to Chem. Fabrik Griesheim-Elektron, Frankfurt a. Main						
Catalytic body (for use in making HNO_3) and method of making same				971,149	380,884	27-22
SINDING-LARSEN, A., and NORSKE AKTIESELSKAB FOR ELEKTRO-KEMISK INDUSTRI						
Concentration of dilute nitrous gases					375,342	26-924
SPITZER, F. Essen (Germany)						
Mfr of N oxides electrically			22,201	.....	383,136	....
					383,078	
STEINMETZ, C. P. Assignor to the General Electric Co.						
Electrical production of nitrous compounds				865,618		26-1097
1908						
AKTIESELSKABET DET NORSKE KVAELSTOFKOMPAGNI						
Mfr of HNO_3 and nitrites			6,265			27-501
ALLGEM. ELEKTRIZITÄTSGESELLSCHAFT, Berlin						
Concentration of nitric oxide (arising out of the electrical oxidation of atmospheric N)			8,426			28-937
BADISCHE ANILIN- U. SODA FABRIK						
Production of nitrous products (HNO_3 and nitrogen peroxide) by combustion			20,406		396,375	28-599
Mfr of NH_3			2,414		387,002	27-809
Process for the production of nitric oxide by means of electric arcs				227,012		29-1378
Process for the preparation of solid nitrates from nitrous gases mixed with air or O			10,867	210,167		28-656
Production of cyanides and cyanamides					387,001	27-809
BENDER, O., Potsdam (Germany)						
Process for the mfr of oxides of N	.....	217,079	1,011,014	.....		29-152
BIRKELAND, K., Christiania (Norway)						
Electric furnace	.....	.....		906,682	.....	28-96
BUNET, P., and BADIN, A., Assignors to Compagnie des Produits Chimiques d'Alais et de la Camargue Salindres (France)						
Method of producing cpds of O and N			1,035,684		402,012	28-1198
Apparatus for producing electric arcs suitable for forming N oxides			16,937		406,115	29-98

Inventor and Invention	PATENTS: Brit.	German	U. S.	French	REFERENCES: J. S. C. I.	v. Note 16
1908						
COMPAGNIE POUR LA FABRICATION DES COMPTEURS ET MATÉRIAL D'USINES À GAZ Process and apparatus for treating cyanamide to form NH_3 and ammonium sulphate	.....	.....	.....	407,161	29-565	.....
DAHL, O. H. Preparation of oxygenated compounds (nitrogen oxides)	.....	.....	391,822	27-1152	.....	.....
DIEFFENBACH, O., and MOLDENHAUER, W., Darmstadt Process of producing nitric oxides and HNO_3	.....	.....	914,813	389,500	28-365	.....
ELEKTROCHEMISCHE WERKE G.M.B.H. Process of producing electric discharges of high efficiency. (Fixation of atmospheric N)	.....	.....	389,112	27-986	.....	.....
Process for concentrating oxides of N when mixed with much air	.....	.....	388,305	27-939	.....	.....
ENGELS, O., and DUBRE, F. Process for obtaining conc. HNO_3 from conc. nitrous gases, air and water	.....	229,006	.....	.....	30-84	.....
GRAU, A., and RUSS, F. Process and apparatus for making N oxides from air	.....	.....	884,919 884,920	.....	27-501	.....
GUYE, P. A. Process of recovery and utilization of oxides of N	.....	.....	404,630	29-211	.....	.....
HABER, FR., and KOENIG, A. Production of N oxides from air	15,490	.....	938,316	392,670	.....	.....
LIMP, C. Electric furnace with rotating arc, specially applicable to the nitrification of atmospheric N	.....	.....	403,536	.....	.....	.....
MOSCIZKI, I. Process and apparatus for the production of N oxides by means of a rotating electric arc	21,959	.....	920,610	395,424	28-529	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB Simultaneous production of HNO_3 and nitrites	.....	.....	.....	388,276	27-897	.....
OSTWALD, W., Gross-Bothen Catalytic apparatus for transforming NH_3 into oxides of N	7,909	.....	.....	389,059	27-898	.....
PAULING, H. Assignor to Salpetersaure-Industrie-Gesellschaft, Gelsenkirchen Apparatus for the mfr of HNO_3 or nitric oxide	.....	.....	877,446	.....	27-160	.....
Process for the production of pure HNO_3	.....	.....	877,447	.....	27-160	.....
Process for mfr HNO_3 by means of superheating	.....	.....	882,958	.....	.....	.....
PICKET, R. P. Process for the preparation of N_2O and NO	226,867	.....	.....	.....	29-1250	.....
POLLACCI, E. and G. Mfr of nitrogenous cpds ($CaCN_2$), utilizing atmospheric N	.....	.....	.....	391,693	27-1167	.....
ROBERTS, J. L. Method of producing nitric oxide	.....	.....	902,607	.....	27-1152	.....
SALPETER-SAURE INDUSTRIE-GESELLSCHAFT Mfr of commercially pure HNO_3	.....	.....	.....	374,327	.....	Nov. 2, 1908
Furnace for treating gases by the electric arc	.....	216,090	.....	406,442	28-1317	.....
SZEI METZ, C. P. Assignor to General Electric Co. Apparatus for mfr nitrous cpds (electrically)	.....	.....	894,547	.....	27-905	.....
1909						
AKTIEBOLAGET SWEDISH NITRIC SYNDICATE Process and apparatus for the continuous conc. of acids, the extraction of HNO_3 by distillation from mixtures containing H_2SO_4, etc.	.....	.....	.....	402,078	28-1197	.....
Process and apparatus for the conc. of HNO_3	10,592	.....	.....	402,079	28-1197	.....
BADISCHE ANILIN- U. SODA-FABRIK Process of preparing alkali or alkaline-earth cyanides and cyanamides (from nitrides)	.....	200,986 245,662	.....	.....	30-1058	.....
Mfr of NH_3 from titanium nitride or cyanonitride	.....	2,225	.....	.....	28-309	.....
Mfr of NH_3	.....	.....	911,468	372,714	26-527	.....
Mfr of NH_3	30,380	.....	.....	405,712	29-950	.....
Production of N cpds of Si and their employment for obtaining NH_3	.....	.....	993,144	405,712	29-424	.....
Mfr of NH_3 and apparatus therefor	17,951	.....	1,202,995	406,943	29-488	.....
Process for the conversion of nitrites into nitrates by means of HNO_3	.....	223,026	.....	.....	29-879	.....
Method for effecting the removal of nitrous acid from solutions containing it	30,503	.....	.....	411,674	29-494	.....
Mfr of nitrates	30,502 40,563	.....	.....	411,674	29-949	.....
Absorption of N oxides	10,465	.....	.....	.....	29-423	.....
Process for the conversion of nitrites into nitrates by means of HNO_3	11,274	220,539	.....	.....	29-565	.....
Transformation of nitrites into nitrates	.....	.....	.....	398,738	28-884	.....
NO_2 free from HNO_3	.....	231,805	.....	.....	30-421	.....
BENDER, O., Potsdam (Germany) Process for the production of oxids of N	18,203	.....	.....	405,463	29-211	.....
BOSCH, C., and MITTASCH, A., Assignors to Badische Anilin- u. Soda Fabrik, Ludwigshafen on Rhine Process of producing cyanides and cyanamides	.....	235,662	1,022,351	.....	30-1058	.....
Production of cyanide and cyanamide	.....	.....	923,012	387,002	.....	.....
BUNET, P., and BADIN, A. Production of cpds containing O and N by electrical means	.....	.....	.....	402,012	29-1377	Aug. 10, 1909
Apparatus for the production of electric arcs intended for the formation of cpds of O and N	.....	.....	.....	406,113	29-1212	June 26, 1909
Production of cpds of O and N by electrical means	16,224	.....	.....	402,012	28-1198	.....
Production of cpds containing O and N by electrical means	.....	.....	.....	402,012	29-1212	June 26, 1909
DIEFFENBACH, O., and UEBEL, C. Process for the conc of dilute HNO_3	.....	238,370	.....	.....	30-1312	.....
Electric furnace for gas reactions	.....	.....	941,768	.....	29-32	.....
DU PONT, F. I., Assignors to the F. I. du Pont de Nemours Powder Co., Wilmington, Del. Production of oxides of N from the air	.....	.....	943,661	.....	.....	.....
DYNAMIT- AKT. GES. VORM. A. NOBEL U. CIE Process for obtaining oxides of N from air	228 849	.....	.....	.....	30-86	.....
GLASER, L., Assignor to General Elec. Co. Process of obtaining HNO_3 from gas mixtures containing oxides of N	.....	.....	921,975	.....	28-656	.....
HAUSSER, F. Process for preparing oxides of N by explosive combustion	.....	.....	.....	409,758	29-696	.....
LE NITROGÉNE SOC. ANONYME Apparatus for the mfr of oxides of N by means of the electric arc projected in a mixture of O and N	.....	.....	.....	404,239	29-211	.....
Process for preparing HNO_3 of about 65 per cent strength by the absorption in water of oxides of N mixed with a gas containing O	.....	.....	.....	404,720	29-211	.....
NAVILLE, A. A., and GUYE, C. E. Self-regulating apparatus for submitting gases and vapors to the action of the electric arc	.....	.....	.....	350,120	29-1117	May 22, 1909
PAULING, H. Improvements relating to the working of electric arcs in series. (Increasing the efficiency of electric flame arcs of high tension in series)	6,429	.....	.....	400,745	28-943	.....
PAULING, G., Gelsenkirchen Method of producing nitrous gases	22,037	.....	.....	.....	29-211	.....

Inventor and Invention	PATENTS: Brit.	German	U. S.	French	REFERENCES: J. S. C. I.	v. Note 16
1909						
SALTPETERSÄURE INDUSTRIE-GES. Gelsenkirchen Electric furnaces for the treatment of gases by means of flame arcs	19,466	216,090	.....	.....	29-221	.....
Electric furnaces for the treatment of gases or gas mixtures	8,413	.....	.....	400,771	28-715	.....
Preparation of conc. nitrous gases from dilute HNO_3	.....	.....	.....	407,133	29-565	.....
SCHÖNHERR, O., and J. BRODE, Assignors to Norsk Hydro-Elektrisk Kvaelstofaktieselskab Process of making nitrates and HNO_3	.....	220,539	1,039,325	.....	.....	.....
Process for producing electric arcs	22,715	.....	1,003,209	418,892	29-1167	.....
SERPEK, O. Process of making Al nitride	15,996	.....	.....	415,216	28-1198	.....
Process for making Al-N cpds	15,995	.....	.....	367,124	29-25	July 6, 1909
Process for producing NH_3 from Al nitride	15,997	.....	.....	415,252	28-1126	.....
Process for making Al nitride	7,507	.....	{1,016,526 987,408	411,031	29-277	.....
SOC. L'AIR LIQUIDE (SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉ DES G. CLAUDE) Process and apparatus for the fixation of N and O at high temperature	.....	.....	.....	416,557	29-1378	.....
SOC. LE NITROGÈNE Process of recovering nitrous vapors or N oxides diluted by inert gases	.....	.....	.....	421,313	30-542	.....
1910						
BADISCHE ANILIN- U. SODA FABRIK Process for the production of cpds of Al and N	16,368	.....	1,027,312	418,425	30-86	.....
Production of NH_3	17,642	.....	971,501	417,446	29-949	.....
Process for the production of voltaic arcs burning permanently	.....	.....	.....	413,421	29-1117	.....
Process for the absorption of nitrous gases	.....	.....	.....	412,788	30-684	Nov. 9, 1910
Process for dissipating the mist which forms in nitrous gases	.....	.....	233,729	.....	30-747	.....
Production of NH_3	.....	.....	.....	1,006,206	417,490	30-26	.....
Process of producing NH_3	{19,249 19,250 19,251	.....	.....	{1,091,194 1,148,570 1,152,000	425,099	30-1012	.....
Process for the production of NH_3	13,097	.....	.....	.....	418,434	30-85	.....
Process for the production of NH_3 from its elements	15,973	.....	.....	.....	418,287	30-85	.....
Production of NH_3 and Al cpds	5,382	.....	.....	.....	418,059	30-26	.....
Catalytic mfr of NH_3	3,127	.....	.....	.....	.....	30-747	.....
Process for the production of NH_3	10,441	.....	.....	.....	416,877	29-1378	.....
Process of absorbing nitrous gases	.....	.....	.....	.....	412,788	29-1010	.....
BAYRISCHE STICKSTOFFWERKE AKT.-GES. Process for the mfr of NH_3 from crude $CaCN_2$ by means of water and steam	.....	.....	236,705	.....	.....	.....
BOSCH, C., and KELLER, H. Assignors to Badische Anilin- u. Soda Fabrik Process of absorbing oxides of N	.....	.....	1,029,528	412,788	29-1010	.....
BOSCH, C., and MITTASCH, A., Assignors to Badische Anilin- u. Soda Fabrik Process of producing NH_3 and Al cpds	.....	.....	1,043,798	418,059	31-1127	.....
BOSCH, C., and WILD, W., Assignors to Badische Anilin- u. Soda Fabrik Process of making nitrates from nitrites	.....	.....	1,013,984	411,674	.....	.....
BROCHET, A., and G. BOITEAU Process of preparing NH_3 and its derivatives	.....	.....	.....	425,952	30-1012	.....
CARLSON, O. F. Process and electric furnace for the continuous preparation of N cpds ($CaCN_2$) by means of alkaline-earth carbides and N	.....	.....	.....	417,054	.....	.....
CARO, N. Mfr of NH_3 from N and H	.....	272,638	.....	.....	33-593	.....
COLLETT, E., and ECKARDT, M. Process of utilizing the products of decomposition of certain cyanogen cpds	.....	.....	1,003,433	412,768	29-1010	.....
DU PONT, F. I., Assignor to F. I. du Pont de Nemours Powder Co., Wilmington, Del. Process for producing oxides of N from the air	.....	.....	948,372	.....	.....	.....
Apparatus for producing oxides of N from the air	.....	.....	950,703	.....	.....	.....
ELEKTROCHEM. WERKE G.M.B.H. Process for the extraction of pure N peroxide from mixtures of nitric oxide and air obtained electrically	.....	.....	.....	411,093	29-949	.....
GUYE, P. A., Geneva Process of recovering nitrous vapors or oxides of N diluted in indifferent gases	.....	.....	.....	1,057,052	441,022	30-541	.....
Apparatus (electric furnace) for producing endothermic reactions in gases	.....	.....	.....	1,035,581	420,524	30-372	.....
HABER, F., Karlsruhe, Germany Mfr of NH_3	14,023	.....	.....	999,025	.....	29-1453	.....
HALVORSEN, B. F. Assignor to Norsk Hydro-Elektrisk Kvaelstof-Aktieselskab, Christiania Method of absorbing dilute nitrous gases	.....	.....	.....	948,726	380,190	26-1280	.....
HÄUSSER, F. Process of obtaining N oxides by the explosion of gaseous mixtures containing N and O	.....	.....	.....	20,777	420 112	30-360	.....
HLAVATI, F. Catalytic combustion of N with H or with O	.....	.....	975,663	.....	.....	33-1009	.....
Catalytic preparation of NH_3 from its elements	.....	.....	977,054	.....	.....	33-1154	.....
KAISER, K., Wilmersdorf (Germany) Method of making N-O cpds	20,325	.....	.....	.....	419,782	29-1377	.....
Process of oxidation of atmospheric N by means of flame or spark electric discharges	12,224	.....	.....	864,925	415,976	29-1306	.....
MATIGNON, A., Assignor to Société Générale des Nitrures Synthetic production of NH_3	.....	.....	.....	{1,089,240 1,089,241	430,595	30-1381	.....
NITROGEN, LIMITED Process and apparatus for obtaining oxides of N	27,558	.....	.....	.....	432,810	30-1211	.....
NOBEL'S EXPLOSIVES CO., LTD., Glasgow, and D. CROSS, Stevenston Process and apparatus for producing oxides of N	{24,007 9,682	.....	.....	.....	.....	30-1211	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB Process for increasing the factor of work ($\cos\varphi$) and the stability of electric furnaces	.....	.....	.....	.....	414,925	29-1317	.....
PAULING, H., Gelsenkirchen Process for conc. aqueous HNO_3 and the like with H_2SO_4 and other hygroscopic substances	22,309	.....	.....	.....	420,804	30-84	.....
Drying of gases or vapors. (Conc. of HNO_3)	8,533	.....	.....	.....	422,902	30-541	.....
Method of conc. aqueous solutions of HNO_3 by means of H_2SO_4 and other hygroscopic agents	22,322	.....	{1,031,864 1,031,865	.....	420,803	30-84	.....
PHILLIPS, W. A., Assignor to Nitrogen Ltd., London Method of obtaining oxides of N	27,558	.....	1,035,732	.....	31-817	.....
PICKET, R. P. Mfr of nitrous and nitric oxides	.....	.....	.....	.....	415,594	29-1250	.....
SALTPETERSÄURE-INDUSTRIE GESELLSCHAFT Process for making pure nitrites and nitrates by absorption of nitrous gases	9,884	.....	.....	991,356	415,749	29-1157	.....
Process of producing N oxides from air, or other mixtures of O and N, and apparatus therefor	22,319	.....	.....	991,357	420,252	30-360	.....
Process for drying gases or vapors (conc. HNO_3)	.....	.....	.....	993,868	422,902	30-541	.....
SÉNÈZ, C., and GENIÈS, L. Process and arrangements for the treatment of gases by the electric furnace, particularly for the mfr of N products	.....	.....	.....	.....	414,726	29-1212	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	REFERENCES French	J. S. C. I.	v. Note 16
1910						
SEFFER, O.						
Mfr of nitrides	.....	.....	.....	426,868	30-1058	.....
Process for the mfr of AlN_3 and other metallic nitrides	13,086	.....	995,032	427,109	30-421	.....
Process for the mfr of Al nitride	.....	.....	.....	430,822	30-1382	.....
Apparatus for the mfr of nitrides such as Al nitride	16,322	.....	.....	427,066	30-361	June 1, 1910
Mfr of nitrides such as that of Al	12,601	.....	{1,044,027 1,030,929	427,066	30-361	.....
Rotary electric furnace, principally for making Al nitride	29,715	.....	.....	430,553	30-1222	Oct. 28, 1910
	29,715	.....	.....	430,553	30-1222	Dec. 8, 1910
Electric resistance furnace for making Al nitride	.....	.....	.....	427,066	31-32	Aug. 3, 1910
Revolving electrical furnace with resistances arranged diametrically	29,299	.....	.....	430,553	30-905	.....
SINDING-LARSEN, A., Assignor to Storm, Bull & Co., Christiania						
Process of making N cpds including nitrides and NH_3	1,042	723	414,837	29-1205		.....
SOC. ANON. LE NITROGÈNE						
Process of recovery of nitrous vapors such as oxides of N, diluted with indifferent gases	.....	.....	424,313	30-620		Oct. 1, 1910
Process of recovering nitrous vapors diluted with mixtures of N and O by cooling	.....	.....	.....	421,022	30-541	.....
SOCIÉTÉ GÉNÉRALE DES NITRURES						
Production of nitrides from N, charcoal and metallic oxides	.....	238,340	.....	.....	30-1313	.....
SÖDERMAN, K.						
Apparatus for the mfr of HNO_3	.....	.....	.....	416,036	29-1377	.....
Mfr of N_2O	.....	.....	.....	411,785	29-949	.....
TIMAR, D.						
Mfr of N oxides	.....	.....	.....	412,227	29-1010	.....
TOFANI, G.						
Process and apparatus for the continuous mfr of crude $CaCN_2$	.....	246,077	.....	.....	31-587	.....
WIEGOLASKI, F. H. A., and SCHÖNHERR, A.						
Production of continuous electric arcs and apparatus therefor	.....	.....	1,028,516	413,421	29-1117	.....
1911						
ALBY UNITED CARBIDE FACTORIES, LTD.						
Process for making NH_3 from nitrolim	18,207	.....	.....	433,306	30-1252	.....
BADISCHE ANILIN UND SODA FABRIK						
Process for the catalytic production of NH_3 from its elements with help of pure iron as catalytic agent	24,653[4]					
	25,252[5]		{1,083,585	436,472	31-432	.....
	9,841[6]		{1,158,167			
Mfr of NH_3	21,151	.....	.....	.....	31-1031	.....
Preparation of N cpds of W	.....	259,647	.....	.....	32-657	.....
Production of voltaic arcs of great dimensions	.....	.....	.....	357,358	30-905	Jan. 26, 1911
Catalytic agents for use in mfr of NH_3	{5,833					
	{5,834	.....	.....	.....	30-1115	.....
	5,836					
Mfr of NH_3 and catalytic agents for use in its mfr			{1,068,966			
			{1,068,967			
	5,835	.....	{1,068,968	.....	30-1115	.....
			1,068,969			
Mfr of NH_3	161	.....	1,053,951	.....	30-1057	.....
Process for preparation of NH_3	19,778	.....	.....	429,696	30-1211	.....
Process for producing NH_3, from N cpds of Mo	25,749	.....	.....	431,295	30-1381	.....
Mfr of NH_3	25,749	.....	1,053,952	436,680	31-385	.....
COMPAGNIE BORDELAISE DES PRODUITS CHIMIQUES						
Process of fixation of N in form of NH_3	.....	.....	.....	440,217	31-722	.....
Process of fixation of N in form of O cpds	.....	.....	.....	440,218	31-722	.....
COUTAGNE, G.						
Synthetic process for mfr of NH_3	.....	.....	.....	436,710	31-432	.....
Electric furnace for mfr of nitrides	.....	.....	.....	437,789	31-432	.....
Process of mfr of nitrides in the electric furnace	.....	.....	.....	437,504	31-535	.....
Process of mfr of nitrides in the electric furnace	.....	.....	.....	437,504	31-1032	June 29, 1911
Electric furnace for the mfr of nitrides	.....	.....	.....	436,789	31-544	Feb. 25, 1911
Electric furnace for mfr of nitrides	.....	.....	.....	436,789	31-922	May 27, 1911
DEVILLE, L. P						
Mfr of NH_3	2,116	.....	.....	429,140	30-1211	.....
DYNAMIT AKT.-GES. VORM NOBEL & CO.						
Production of gaseous reactions in the voltaic arc	3,342[3]	242,210	.....	433,836	31-238	.....
ELECKTROCHEM. WERKE G.M.B.H.						
Process for mfr of NH_3 and its cpds from oxides of N, such as H, water-gas or a suitable hydro-carbon	5,282	.....	.....	426,307	30-1012	.....
ELLIS, C.						
Process for forming N oxides	.....	.....	1,007,683	.....	30-1382	.....
Electrical oxidation of N	.....	.....	1,002,249	.....	.....	.....
FARBWERKE VORM. MEISTER, LUCIUS U. BRÜNING						
Process for making HNO_3	19,032	.....	.....	433,502	30-1381	.....
Mfr of HNO_3	15,948	.....	.....	432,990	31-127	.....
HÄUSSER, F. Kaiserslautern (Germany)						
Process of making nitric oxide and HNO_3	.....	.....	1,000,732	.....	30-1115	.....
HELFENSTEIN, A.						
Production of gaseous reactions in electric furnaces	26,371	.....	.....	436,828	31-499	.....
KAISER, K.						
Process of oxidizing atmospheric N (NH_3 by auto-oxidation)	24,035	.....	.....	435,397	31-385	.....
KOCH, C. F. R. VON						
Method of and means for heating gases to high temperatures for the production of endothermic reactions such as the oxidation of N	14,528	.....	1,065,144	.....	31-490	.....
Process for obtaining oxides of N formed in gases at high temperature	.....	.....	.....	435,733	31-385	.....
LIEBOLM, J. H., Alby (Sweden)						
Process for producing NH_3 from $CaCN_2$	18,207	.....	.....	.....	30-1252	.....
MEYER, E. H., and STILLESEN, J. M. A.						
Preparation of $CaCN_2$	.....	.....	982,288	.....	.....	.....
MONTLAUR, A. DE						
Catalyst for the oxidation of NH_3	.....	.....	.....	445,857	32-23	.....
MÜLLER VON BERNECK, R., MOEST, M., and CHAP, H., Assignors to Farbwerke vorm. Meister, Lucius, und Brüning, Höchst im Main						
Process of producing pure nitric oxide	10,522	.....	1,021,234	.....	30-955	.....
NITROGEN LTD.						
Process and apparatus for obtaining oxides of N	4,268	.....	.....	432,810	30-1211	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIELSKAB						
Process of treating mixtures of nitrites and nitrates for the preparation of pure nitrites and nitrates	.....	.....	.....	425,997	30-1014	.....
OESTERR. VEREIN FÜR CHEM. UND METALL. PRODUKTION						
Mfr of NH_3 from crude $CaCN_2$ and water	.....	251,934	.....	.....	31-1125	.....
PATLING, H., Assignor to Salpetersäure-Industrie Gesellschaft, Gelsenkirchen						
Electric furnace for treating gases	3,251	.....	999,557	.....	.....	.....
Electric furnace	{14,121	.....	999,558	.....	30-1071	.....
Absorption of nitrous gases	{14,122	.....	1,037,977	430,113	30-1252	.....
SALPETERSÄURE INDUSTRIE- GES. M.B.H.						
Furnace for production of endothermic reactions of gases by means of the electric arc	.....	.....	.....	433,112	31-138	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	REFERENCES French	J. S. C. I.	v. Note 16
1911						
SCHICK, K., Siegen (Germany), and AKTIENGESELLSCHAFT FÜR STICKSTOFFDÜNGER						
Process of making $CaCN_2$	.....	.....	1,008,927	430,060	30-1313	.....
SCHLOESING, A. T.						
Process for the absorption of dry and hot nitrous vapors by a base such as lime	.....	.....	.....	441,607	19-922	.....
SINDING-LARSEN, A., and STORM, O. J.						
Process for fixing or combining and utilizing N contained in atmospheric air (for production of fertilizers)	12,314	.....	1,031,477	431,182	30-1382	.....
LE NITROGÈNE SOC. ANON.						
Process for the preparation of conc HNO_3 starting with NO_2	{319	.....	.....	424,598	30-684	.....
	{403					
SOCIÉTÉ GÉNÉRALE DES NITRURES						
Mfr of nitrides and NH_3 from N	5,795	.....	.....	438,248	31-641	.....
Revolving electric furnace for the mfr of Al nitride	16,406[1]	.....	.....	430,553	31-1136	Aug. 4, 1911
Process of obtaining nitrides of B and Al and NH_3 from mixtures of boric acid and alumina or their cpds	3,344[1]	.....	.....	437,168	31-432	.....
SPARRE, F., Assignor to the E. I. du Pont de Nemours Powder Co., Wilmington	.....	.....	1,005,383	.....	30-1450	.....
STILLESEN, J. M. A., Niagara Falls						
Preparation of nitrolim	.....	.....	982,311	.....	.....	.....
WASHBURN, F. S., Assignor to American Cyanamide Co., Baltimore						
Method of making cyanamide	.....	.....	1,004,509	.....	.....	.....
Apparatus for producing $CaCN_2$	.....	.....	999,071	.....	.....	.....
WEBER, O. H., and K., Assignors to Chem. Fabrik Griesheim-Elektron, Frankfort						
Process and electric furnace for producing gas reactions	1,042,179			436,201	31-432	.....
1912						
ANDRIESSENS, H., and SCHEIDEMANDEL, J.						
Method of carrying out chemical gas reactions by means of an electrical discharge	16,296	.....	.....	.....	31-1083	.....
BADISCHE ANILIN- U. SODA FABRIK						
Process for carrying out operations employing H or gases which contain it	.....	.....	.....	441,695	32-142	July 26, 1912
Mfr of pure NH_3	25,259	.....	.....	455,950	32-909	.....
Absorption of synthetic NH_3	25,260	.....	.....	.....	32-1155	.....
Mfr of H and NH_3 by the interaction of CO and steam under a pressure of 4 to 40 atmospheres at 300 to 600 deg. C. in the presence of a catalyst	26,770	.....	.....	.....	33-22	.....
Process for producing NH_3	{21,151[6] 3,345	.....	.....	425,099	.....	Aug. 16, 1912
Method of production of oxides of N by means of electric flame arcs	.....	.....	265,413	.....	32-1068	.....
Preparation of N cpds of Mo from its O cpds	.....	.....	259,648	431,295	32-657	Jan. 9, 1913
	.....	.....	1,259,649			
Carrying out operations with H under pressure and at a raised temperature	28,200	.....	.....	456,963	32-1009	.....
Operations in which H is employed under pressure and at high temperatures in iron tubes or vessels. (Several alloys)	29,260	.....	.....	1,086,130	458,218	32-1010
Process of producing NH_3 and catalytic agents for use in said process of mfr	28,167	.....	.....	1,118,628	425,099	31-1125
Process of production of NH_3	22,352	.....	.....	.....	449,010	32-487
Catalytic mfr of NH_3 from its elements	.....	.....	276,133	.....	34-27	.....
Process of production of NH_3	9,842	.....	.....	1,089,185	431,295	32-233
System of absorption of NH_3	25,263	.....	.....	.....	.....	32-1155
Process for carrying out operations employing H or gases containing it	8,617	.....	.....	.....	444,455	31-1126
Process for the catalytic production of NH_3 from its elements	.....	.....	.....	1,149,510	439,261	31-721
Process for carrying out operations employing H or gases containing it	.....	.....	.....	1,188,530	441,695	31-922
Mfr of NH_3	3,345	.....	.....	1,128,843	.....	31-1031
BUCHER, J. E.						
Fixation of N	.....	.....	.....	1,091,425	455,799	32-943
CENTRALSTELLE FÜR WISSENSCHAFTLICH-TECHNISCHE UNTERSUCHUNGEN						
Apparatus for working with H or mixtures containing it under pressure and increased temperature, in synthesizing NH_3	.....	.....	290,877[6]	.....	.....	.....
COUTAGNE, G.						
Mfr of nitrides	.....	.....	.....	457,992	32-1010	.....
Process of mfr of nitrides	.....	.....	.....	457,992	33-255	Nov. 8, 1912
Process and electric furnace for the mfr of Al nitride	.....	.....	.....	462,462	33-312	.....
DU PONT DE NEMOURS POWDER CO., E. I.						
Method of obtaining oxides of N from atmospheric air	17,048	.....	.....	446,269	32-141	.....
ELEKTROCHEMISCHE WERKE GES. M.B.H.						
Process for the production of pure nitrites by means of nitrous gases containing air or oxygen	10,479	.....	.....	441,706	31-922	.....
EPHRAIM, J.						
Separation of easily condensed or absorbed constituents from hot, compressed gaseous mixtures	.....	276,718	.....	.....	33-1154	.....
GELINI, G., Como (Italy)						
Process and apparatus for the production of Al nitride from bauxite or other aluminiferous materials	23,874	.....	.....	451,405	32-600	.....
GROHMANN, H., Innsbruck						
Electric furnace for endothermic gas reactions	919	.....	1,035,873	.....	31-592	.....
GUYE, C. E., Geneva (Switzerland)						
Stabilizing voltaic arcs	804	.....	1,109,330	438,783	31-649	.....
HOOFNAGLE, W. J.						
Electrical treatment of gases and vapors	.....	.....	.....	448,519	32-432	.....
ISLAND, J. S., Toronto (Can.)						
Apparatus for forming oxides of N	11,363	.....	1,082,529	460,557	32-909	.....
JONES, L. C., MORTON, D. A., and TERZIEV, G. N., Assignors to Semet-Solvay Co.						
Art of oxidizing NH_3	.....	.....	1,037,261	.....	31-922	.....
KUNHEIM UND COMPANIE						
Process of obtaining NH_3 from its elements using cerium nitride as catalyst	.....	.....	276,986	.....	33-1154	.....
NAEF, E. E., Clydach						
Mfr of NH_3 and HCN from $CaCN_2$	14,412	.....	.....	.....	32-424	.....
PATLING, H., Assignor to Salpetersäure-Industrie Gesellschaft, M.B.H., Cologne (Ger.)						
Electric furnace for producing gas reactions	.....	.....	1,029,886	.....	31-691	.....
Electrode for producing gas reactions by means of the electric arc	21,478	.....	1,029,885	.....	31-691	.....
PEACOCK, S.						
Cpd of Al, C and N	.....	.....	.....	448,550	32-363	.....
Mfr of cpds of Al, C and N	11,395	.....	1,035,727	.....	31-875	.....
Cpd of Al, C and N. Process of producing NH_3	{11,291	.....	{1,031,581	.....	31-773	.....
	{11,393	.....	{1,031,582			
PIER, M., Assignor to Dynamit Akt. Ges., Hamburg						
Method for the preparation of NH_3 from the elements	.....	252,997	1,119,534	.....	31-1178	.....
SCHEITLEIN, H.						
Arrangement for the utilization of heat produced in electric reverberatory furnaces serving for the preparation of O cpds of N	.....	.....	.....	431,515	32-601	.....
SCHLOESING, A. T., Paris, Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab						
Process for the absorption of nitrous gases or vapors	.....	.....	1,177,359	460,328	33-23	.....
SCHWEITZER, A., and HAUFF, F., Stuttgart						
Process and apparatus for the mfr of cpds of N	3,410	.....	1,037,061	439,872	31-721	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	v. Note 16
1912						
SCOTT, F. K., Bromley (Kent)						
Electric furnace for fixing N from air						
N fixation furnace	14,871	.....	1,113,370	459,660	32-872	.....
	16,014	.....	.....	459,660	32-872	.....
SERPEK, O., Assignor to Société Générale des Nitrures, Paris						
Process for the mfr of Al nitride	8,348	.....	1,094,171	.....	32-875	.....
Process for the mfr of NH_3 by means of Al nitride	10,036	.....	1,040,439	454,430	31-1078	.....
SERRET, A.						
Process of synthesis of NH_3 by means of C	.....	.....	.....	462,683	33-312	.....
SIEBERT, W., Rheinfelden (Germany)						
Electrical method of producing oxides of N from their components	.....	.....	1,033,126	.....	31-782	.....
SINDING-LARSEN, A., Assignor to Storm, Bull & Co.						
Process of making N cpds including nitrides and NH_3	1,042,723	.....	.....	.....	.....	.....
SOCIÉTÉ GÉNÉRALE DES NITRURES						
Electric heating resistances applicable to electric furnaces	12,837	.....	.....	458,031	32-1019	.....
Method of heating electric furnaces, more particularly applicable to the mfr of Al nitride	24,177	.....	.....	463,280	33-457	.....
Process for making Al nitride	8,347	.....	.....	460,178	31-1096	.....
Process for making Al nitride	8,349	.....	1,078,313	460,150	31-875	.....
Process for the mfr of Al nitride	22,435	.....	.....	427,109	32-233	May 18, 1912
WALLACE, R. W., and WASSMER, E.						
Production of NH_3 from N	18,450	.....	1,083,232	464,692	33-22	.....
WEBER, P.						
Continuous process for the mfr of NH_3 by direct reaction between water and KCN	.....	.....	.....	445,506	32-23	.....
WINSTANLEY, T., and WILLIAMS, F. H.						
Mfr of NH_3 and its salts	21,304	.....	.....	.....	32-1009	.....
WOLF, J.						
Preparation of NH_3 from a mixture of CO, N, and water		281,317	.....	.....	34-612	.....
ZENTRALSTELLE FÜR WISSENTSCHAFTLICH-TECHNISCHE UNTERSCHUNGEN GES M.B.H.						
Preparation of NH_3 from its elements by the aid of a catalyst (Ruthenium)	14,585	252,997	.....	450,465	31-1178	.....
1913						
ALUMINIUM INDUSTRIE-AKTIENGESELLSCHAFT						
Preparation of Al nitride in electric furnaces heated by the electric arc	.....	.....	.....	465,807	33-643	.....
BADISCHE ANILIN-U. SODA FABRIK						
Process for the catalytic production of NH_3	24,824	.....	.....	466,303	33-645	.....
Preparation of catalytic agents for the mfr of NH_3	12,977	.....	.....	.....	33-483	.....
Production of oxides of N by oxidation of NH_3 in presence of catalysts	9,264	.....	1,094,182	464,327	33-519	.....
Absorption of NH_3	9,654	.....	.....	.....	32-1155	.....
Process for extracting NH_3 from gaseous mixtures containing it	458,951	.....	.....	.....	32-1155	.....
Operations in which H is used under pressure and at high temperatures in iron tubes or vessels	13,258	.....	.....	458,218	32-1010	.....
BENDER, O.						
Process of obtaining cpds of N with O and with H	.....	279,007	.....	474,107	34-228	.....
Mfr of N cpds	.....	277,435	.....	.....	34-177	.....
CLASSEN, A.						
Mfr of NH_3 from its elements	.....	289,795	.....	.....	35-423	.....
COLLETT, E. Assignor to Norsk Hydro-Elektrisel Kvaelstofaktiesel kab, Christiania						
Process of conc dilute HNO_3	7,597	.....	1,134,289	.....	33-482	.....
Process of conc. dilute HNO_3	22,746	.....	1,138,181	.....	33-482	.....
			1,138,400			
COUTAGNE, G						
Electric furnace principally for the mfr of nitrides (especially Al nitride) and its mode of utilization	12,057	.....	1,158,899	469,554	34-80	.....
Process for making N cpds.	.....	.....	.....	472,465	34-491	.....
FARBENFABR. VORM. F. BAYER & CO.						
Process for preparing NH_3 from its elements	16,903	.....	.....	460,859	33-76	.....
FARBWERKE VORM MEISTER, LUCIUS UND BRÜNING, HOCHST A/M. (Germany)						
Process of obtaining N simultaneously with oxides of N	28,737	.....	1,096,392	453,845	33-483	Dec. 8, 1913
			1,096,393			
Process for the simultaneous production of N and oxides of N	3,662	.....	.....	453,845	32-791	.....
GUILINI, GEBR GMBH.						
Mfr of nitrides	22,837	.....	.....	463,232	33-421	.....
HABBER, G., and SCOTT, F. K.						
Electric furnaces for fixing N from the air	866	.....	.....	.....	32-664	.....
HAYDEN, J. L. R., Assignor to General Elec Co						
Chemical reaction by means of an electric arc. Production of nitric oxide from atmospheric air	.....	.....	1,066,272	.....	32-977	.....
HERMAN, E.						
Preparation of oxides of N by combustion of air with the aid of C cpds	.....	281,084	.....	.....	34-613	.....
HLAVATI, F.						
Process of mfr of cpds of N and H (NH_3) and of N, H and O	1,142	.....	1,079,705	453,207	32-791	.....
KOCHMANN, W., Berlin						
Apparatus for carrying out gas reactions, particularly for the production of oxides of N in the electric arc	.....	.....	1,055,331	.....	32-425	.....
KOEPP, R. UND CO., Oestrich (Germany)						
Production of mixtures of N and H suitable for the mfr of NH_3	30,073	.....	1,098,139	.....	33-788	.....
KOPPERS, H.						
Mfr of NH_3 from cpds containing C and N	.....	285,354	.....	.....	34-1142	.....
KRAUSS, C., and STACHELIN, P.						
Preparation of cpds of N and O by surface combustion	26,199	.....	.....	465,045	33-549	.....
LACHMANN, W., Dresden						
Method of producing cpds of N and O, especially N oxides from free N	.....	289,814	.....	.....	35-538	.....
LESSING, R.						
Separation of particles easily condensed or absorbed from those which are not easily condensed or absorbed, from mixtures of hot compressed gases (NH_3 from H and N)	.....	.....	.....	466,102	33-644	.....
LYNN, A. H., London						
Process and apparatus for the mfr of N oxides or oxyacids	3,194	.....	.....	.....	33-352	.....
MARCOLES, J.						
Mfr of nitride of iron and, in general, of metallic nitrides, especially for use as fertilizers, or as a source of production of NH_3	.....	.....	.....	465,265	33-349	.....
MASCIONI, I.						
Electric furnace with rotating flame for the treatment of gases and vapors	13,250	.....	1,201,607	458,636	32-1076	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	v. Note 16
1913						
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB						
Improvements relating to the direction given the gases in electric furnaces with arcs spread magnetically	.....	.....	.....	.....	466,100	33-601
OESTERR. VEREIN F. CHEM. UND METALL. PRODUCTION						
Catalytic oxidation of NH_3 obtained from cyanamide by means of air or other gas containing O	.....	.....	276,720	.....	34-28	.....
PAULING, H.						
Process for conc. aqueous HNO_3	.....	.....	.....	1,074,287	461,326	32-1009
PÉNIAKOFF, D.						
Mfr of double N cpds of Al and alkali or alkaline-earth metals	.....	.....	.....	1,159,989	465,679	33-644
ROSSI, C., Legnano (Italy)						
Production of nitric oxide by electric oxidation of atmospheric N	.....	.....	23,959	.....	463,821	33-421
Production of conc. HNO_3 by treatment of dilute HNO_3	.....	.....	.....	.....	463,830	33-421
Mfr of conc. HNO_3 by treatment of the diluted oxides of N obtained by electric oxidation of atmospheric air	.....	.....	24,970	.....	.....	.....
Process for the conc of HNO_3 by means of dehydrating agents, H_2SO_4 for example	.....	.....	.....	.....	455,432	32-913
Process of conc of dilute HNO_3	.....	.....	.....	.....	455,531	32-943
Process of oxidation of atmospheric air by means of the electric arc	.....	.....	.....	.....	455,530	32-943
SCOTT, F. K., Bromley (Kent)						
Method for starting the arcs of electric furnaces	6,196	.....	.....	.....	33-427	.....
Method for regulating arc furnaces	4,725	.....	.....	.....	33-361	.....
Electrodes for electric furnaces for the fixation of N	4,723	.....	.....	.....	33-361	.....
SIEBERT, W., Assignor to General Elec. Co.						
Electrical device for synthetizing gas	.....	.....	1,061,786	.....	32-665	.....
SOCIÉTÉ GÉNÉRALE DES NITRURES, Paris						
Process for the fixation of N by means of ferro-aluminium or other ferro-compounds	28,071	.....	.....	.....	33-483	.....
Method of obtaining Al nitride by heating alumina or aluminous materials and C in an atmosphere containing N	23,740	.....	.....	.....	33-643	.....
Process of oxidizing NH_3	.....	.....	.....	473,618	34-715	.....
Process for fixing atmospheric N	22,586	.....	.....	474,365	34-353	.....
Mfr of Al nitride	24,353	.....	.....	474,820	34-423	.....
Fixation of N by means of ferro-aluminium	.....	.....	1,155,840	471,330	34-1091	.....
Process of fixing N by means of ferro-aluminium	27,118	.....	.....	474,322	34-1054	.....
	27,971	.....	1,198,965	470,099	33-549	.....
Mfr of Al nitride	10,075	.....	.....	457,650	32-1010	.....
Mfr of Al nitride	21,366	.....	.....	.....	33-961	.....
	11,091	.....	.....	457,723	32-1010	.....
STEINMETZ, C. P., Assignor to General Elec. Co., Schenectady						
Production of ammonium compounds	.....	.....	1,062,805	.....	32-699	.....
WAGENER, G., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington						
Electrode for producing arcs	.....	.....	1,055,003	.....	32-432	.....
			1,055,295			
WIELGOLASKI, F. H. A., Christiania						
Production of long electric arcs for the treatment of gases	2,214	.....	1,061,892	.....	32-665	.....
Method and apparatus for producing long electrical arcs	2,165	.....	1,054,886	.....	32-432	.....
ZANARDO, BARZANO DE						
Mfr of $CaCN_2$ by the action of N on Ca carbide	.....	.....	1,164,087	456,826	32-1108	.....
ZANCKER, W.						
Process and apparatus for preparing metallic nitrides or cyanides (e.g. Al nitride) with oxides, or mixtures forming oxides, C or hydrocarbons, and N or gases containing N	.....	.....	.....	458,519	32-1108	.....
Simultaneous preparation of pure alumina and NH_3 by the treatment of Al nitride or mixtures containing this nitride	.....	.....	.....	459,093	32-1155	.....
1914						
ASHCROFT, F. A., London						
Fixation of N as cyanamides or cyanides, with or without subsequent treatment for obtaining NH_3 and alkalies	10,420	.....	1,186,367	.....	34-716	.....
BADISCHE ANILIN- UND SODA FABRIK						
Mfr of oxides of N by the oxidation of NH_3	13,687	.....	.....	.....	34-961	.....
Mfr of oxides of N and of catalysts to be employed in such mfr	13,848	.....	1,211,394	.....	34-799	.....
BAMBACH, A.						
Process for utilizing gas producers for the mfr of NH_3 by synthesis	3,175	.....	.....	469,331	34-79	.....
BERLIN- ANHALTISCHE MASCHINENBAU AKT.-GES.						
Oxidation of NH_3 to N oxides	.....	286,991	.....	.....	35-116	.....
CALVERT, G., London						
Mfr of NH_3 by synthesis	10,612	.....	.....	.....	34-715	.....
CENTRALSTELLE F. WISSENSCHAFTLICH-TECHNISCHE UNTERSUCHUNGEN, NEUBABELSBERG						
Mfr of NH_3 from the elements	.....	288,496	.....	.....	35-360	.....
CLASSEN, A., Aix-la-Chapelle (Germany)						
Electrical production of N cpds	7,866	.....	.....	470,916	34-176	.....
COUTAGNE, G						
Electric furnace principally for the mfr of nitrides (especially Al nitride) and its mode of utilization	.....	.....	.....	469,554	35-633	May 22, 1914
Mfr of NH_3	.....	.....	.....	477,746	35-633	.....
DAFERT, F. W., and MIKLAUZ, R.						
Mfr of NH_3 from atmospheric N	16,597	.....	.....	474,994	34-871	.....
DEVANCELLE, I. PETIT, and BENSA, F.						
Preparation of cyanides and NH_3 or its salts by the Marguerite and Sourdeval process	.....	.....	.....	478,919	35-1109	.....
FARBENFABR. VORM. F. BAYER & CO.						
Mfr of NH_3 from the elements	.....	.....	285,698	.....	34-1143	.....
Mfr of NH_3 from the elements. Production of suitable contact substances	.....	.....	286,719	.....	34-1249	.....
FARBWERKE VORM MEISTER, LUCIUS U. BRÜNING						
Process for the simultaneous production of N and oxides of N	9,974	.....	.....	453,845	34-552	Apr. 17, 1914
HAUSSER, F., Herringen						
Process for the absorption of dilute nitrogenous gases by water	7,419	.....	.....	469,649	34-80	.....
LANDIS, W. S., Assignor to American Cyanamide Co., Nashville (Tenn.)			1,103,060			
Process and apparatus for fixing atmospheric N	.....	.....	1,103,061	.....	33-864	.....
			1,103,062			
MACK, E.						
Process and apparatus for the treatment of gases by the electric arc	.....	.....	.....	477,476	35-608	.....
MILDE, E., Assignor to Aluminium Industrie Aktiengesellschaft, Neuhausen						
Process of producing NH_3 from Al nitride	.....	.....	1,115,003	.....	33-1207	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB						
Electric arc furnace for the oxidation of atmospheric N, with cooling of the resulting gases regulated according to their heat	.....	.....	1,173,999	476,633	35-46	.....
Process for preventing punctures in electric flame arc furnaces	.....	.....	.....	1,148,343	475,989	34-913
Conc. of HNO_3	19,792	.....	.....	.....	.....	34-1053
Admission of gas into electric arc furnaces. Electrodes for electric arc furnaces	.....	.....	1,096,321	466,961	33-872	.....
				466,962		
PEACOCK, S., Assignor to International Agricultural Corporation, New York						
Process of producing NH_3	.....	.....	1,092,167	.....	34-176	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	v. Note 16
1914						
PIER, M., Zehlendorf						
Synthetic process for the production of NH_3 from its elements						
Production of NH_3 from its elements	213	.....	1,157,253	.....	34-870	.....
Apparatus for carrying out reactions between H and other gases	214	.....	.....	.....	34-870	.....
	9,661	.....	.....	.....	35-538	.....
	10,216	.....	.....	.....		
Apparatus for carrying out reactions between H and other gases (synthesis of NH_3)	10,470	.....	.....	.....	35-737	.....
SOCIÉTÉ GÉNÉRALE DES NITRURES						
Process of burning N by means of ferro-aluminium			.....	474,322	35-633	Apr. 21, 1914
Process of fixing atmospheric N		.....	.....	474,365	35-633	Apr. 21, 1914
Electric furnace for the production of Al nitride			.....	475,908	35-46	.....
Fixation of N by means of ferro-aluminium	4,287[1]	.....	.....	476,121	34-961	.....
TOMMASI, N. C., and USINES ELECTRIQUES, DE LA LONZA						
Mfr of $CaCN_2$ and other N cpds	.....	.....	.....	476,294	35-46	.....
TROYE, E., and EDWIN, E., Assignors to Norsk Hydro-Elektrisk Kvaelstofaktieselskab						
Electric arc furnace	.....	.....	1,122,555	474,104	.....	.....
VEREIN CHEM. FABRIKEN IN MANNHEIM						
Catalytic oxidation of NH_3 to oxides of N	12,600	.....	.....	492,567	34-492	.....
WEISE, J., and RIECHE, F., Assignors to R. Koepp & Co., Chem. Fabrik, Oestrich-on-Rhine (Germany)	.....	.....	1,098,139	466,679	33-788	.....
1915						
ALUMINIUM-INDUSTRIE AKTIEN-GESELLS.						
Preparation of Al nitride in electric arc furnaces			.....	468,807	35-1156	Feb. 3, 1915
BADISCHE ANILIN- U. SODA FABRIK						
Catalytic reactions (synthesis of NH_3) and catalytic agents for use therein	1,358	.....	.....	.....	35-689	.....
Mfr of N oxides	13,297	.....	.....	.....	35-1108	.....
Production of oxides of N and catalysts to be employed therein	7,651	.....	.....	.....	35-1015	.....
	13,298					
BRADLEY, C. S.						
Producing chemical action in gases	Mfr of oxides of N	.....	1,134,583	.....	34-552	.....
BUCHER, J. E., Assignor to Nitrogen Products Co., Providence (R. I.)						
Method of producing NH_3 and the like	.....	.....	1,138,191	.....	34-661	.....
ZENTRALSTELLE FÜR WISSENSCHAFTLICH-TECHNISCHE UNTERSUCHUNGEN, Neubabelsberg						
Synthetic production of NH_3 from its elements	2,392	.....	.....	.....	35-360	.....
DU PONT, E. I., Wilmington (Delaware)						
Method of obtaining oxides of N from atmospheric air	.....	.....	1,147,150	.....	34-961	.....
JAHN, F. W. DE, Assignor to General Chemical Co., New York						
Production of NH_3	.....	.....	1,141,948	.....	34-799	.....
Catalyst for the production of NH_3 and process of making	.....	.....	1,159,364	.....	34-1249	.....
	.....	.....	1,159,365	.....		
Production of NH_3	.....	.....	1,151,537	.....	34-1249	.....
Catalyst for the production of NH_3 from N and H, and process of making the same	.....	.....	1,143,366	.....	34-833	.....
LANDIS, W. S., Assignor to American Cyanamide Co., Nashville (Tenn.)						
Process of producing NH_3 from $CaCN_2$	.....	.....	1,154,640	.....	34-1207	.....
Mfr of NH_3 from $CaCN_2$	.....	.....	1,149,653	.....	34-961	.....
Process of making NH_3 from $CaCN_2$	.....	.....	1,163,095	.....	35-115	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB						
Mfr of nitrous gases	.....	.....	1,200,334	477,726	35-601	.....
Process for carrying out gaseous reactions with the aid of air rich in O	.....	.....	.....	480,205	36-215	.....
PEACOCK, S., Assignor to International Agricultural Corporation, New York						
Electric resistance furnace. Process of making N cpds in electric furnaces	.....	.....	1,129,512	.....	34-365	.....
	.....	.....	1,129,513	.....		
RANKIN, H. D.						
Production of HNO_3	.....	.....	.....	479,492	35-1108	.....
SAMUEL, R. A., London						
Treatment of air or gas with an electric arc	1,670	.....	.....	.....	35-315	.....
SCOTT, E. K., and HOWLES, F.						
Electric furnaces for the fixation of N	3,953	.....	.....	.....	35-476	.....
SOCIÉTÉ GÉNÉRALE DES NITRURES, Paris						
Process and apparatus for the mfr of Al nitride	11,271	.....	.....	478,886	35-115	.....
STUMPERS, L. L., Chicago (Ill.)						
Method for producing reactions in gases at high temperatures and apparatus (electric furnace) for practicing the same	.....	.....	1,125,208	.....	34-236	.....

Inventor and Invention	PATENTS Brit.	German	U. S.	French	REFERENCES J. S. C. I.	v. Note 16
1915						
THORSELL, C. T., Gothenburg (Sweden)						
Production of NH_3	11,485	.....	.....	.....	34-1207	.....
Production of NH_3 by heating Ba cyanide with water in an autoclave	11,486	.....	.....	.....	35-963	.....
TROYE, E., Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania						
Apparatus for improving the stability of furnaces with magnetically-extended electric arcs	.....	.....	1,156,192	.....	34-1152	.....
1916						
BOSCH, C., MITTASCH, A., and BECK, C.						
Oxides of N from NH_3[11]	.....	.....	1,207,706	.....	.....	.....
			1,207,707			
			1,207,708			
CLASSEN, A., Aix-la-Chapelle						
Mfr of HNO_3 or nitrates from N oxides	.....	.....	1,178,440	.....	35-633	.....
DÖVLE, C. O. A., Notodden, Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania						
Electric arc furnace for the treatment of gases	.....	.....	1,194,600	.....	35-1023	.....
Electric arc furnace	.....	.....	1,204,349	.....	35-1267	.....
EDWIN, E., Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania						
Electric arc furnace	.....	.....	1,193,882	.....	35-971	.....
ELLIS, E., Montclair (N. J.)						
Process of making NH_3	.....	.....	1,184,839	.....	35-737	.....
FOSS, A., Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania						
Method for producing rotating electric arcs	.....	.....	1,175,252	.....	35-548	.....
GUILINI, G., Lanzaco (Italy)						
Process of producing Al nitride	.....	.....	1,180,840	.....	35-633	.....
HABER, F., and LE ROSSIGNOL, R.						
Synthesis of NH_3[13]	.....	.....	1,202,995	.....	.....	.....
HANSEN, B						
Receptacle for use in producing NH_3 from $CaCN_2$ or other chemical process[14]	.....	.....	1,205,619	.....	.....	.....
HERSHMAN, P. R., Assignor to Armour Fertilizer Works, Chicago						
Method of producing nitrogeneous cpds from Al waste products			1,188,769	.....	35-890	.....
Continuous process of producing nitrogeneous cpds of Al	.....	.....	1,188,770	.....	35-890	.....
Production of nitrogeneous cpds	.....	.....	1,188,771	.....	35-890	.....
HERSHMAN, P. R., Assignor to The Minerals Products Co., New York						
Production of Al nitride	.....	.....	1,188,651	.....	35-890	.....
ISLAND, J. S., Toronto (Can.)						
Device for producing oxides of N	.....	.....	1,179,927	.....	35-633	.....
JENSEN, O. Rjukan, Assignor to Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania (Norway)						
Process of converting nitrous gases into cond. HNO_3	.....	.....	1,197,295	.....	35-1260	.....
LAMB, H. W.						
Producing NH_3[15]	.....	.....	1,207,567	.....	.....	.....
LANDIS, W. S., Assignor to The Ammo-Phos. Corporation						
Apparatus for producing NH_3 from $CaCN_2$	.....	.....	1,183,885	.....	35-737	.....
LANDIS, W. S., Assignor to F. S. Washburn						
Method of oxidizing NH_3	.....	.....	1,193,796	.....	35-968	.....
Process and apparatus for oxidizing NH_3	.....	.....	1,193,797	.....	35-963	.....
Catalyzer and apparatus for oxidizing NH_3	.....	.....	1,193,798	.....	35-963	.....
Platinum catalyzer	.....	.....	1,193,799	.....	35-963	.....
Catalyzer for oxidizing NH_3[16]	.....	.....	1,193,800	.....	35-963	.....
NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB, Christiania						
Process for the mfr of N cpds	10,099	.....	.....	.....	36-214	.....
1917						
BOSCH, C., MITTASCH, A., and BECK, C.						
Catalyst for oxidizing NH_3[15]	.....	.....	1,211,394	.....	.....	.....

NOTES:

[1]Austrian Patent.
[2]Of 1903.
[3]Addition to French Patent.
[4]Swiss Patent.
[5]Of the following year.
[6]Belgian Patent.
[7]First addition, Oct. 11, 1907; second addition, Oct. 12, 1907.
[8]Of the preceding year.
[9]Chem. Abst., V. 11, p. 874.
[10]Jour. Gas Lighting and Water Supply, V. 134, p. 285.
[11]Chem. Abst., V. 11, p. 278.
[12]Chem. Abst. V. 11, p. 192.
[13]Chem. Abst. V. 11, p. 236.
[14]Met. Chem. Engng., XV, 1916, p. 539. Science Abst. (B), 1917, XX, pp. 56-7.
[15]Chem. Abst., V. 11, p. 691.
[16]Date of addition to French Patent.

Coal Gas for Automobiles

The present price for motor car gasoline in England is around 60 cents per gallon and this price has given impetus to the search for substitutes. Coal gas has been tried successfully by motor buses, furnishing an acceptable means of obtaining fuel at a considerably reduced cost.

The only change made in the motor is the fitting of a butterfly valve in the air-intake pipe for the regulation of the air supply, which allows the engine to draw the gas in the correct quantity according to load and speed. It is claimed that an advantage accruing from the use of gas as a fuel is that the engine runs cleaner than with ordinary petrol and the valves do not require grinding so often.

In Yorkshire it is reported that the use of coal gas for automobiles appears to be increasing rapidly. Recently Harrogate adopted it, and now Halifax and Todmorden have decided to give it a trial. The necessary apparatus is relatively cheap and easily adjusted, consisting of a canvas bag with an inner layer of rubber, shaped like a mattress, which holds the gas drawn from the main, and is strapped to the top of the motor omnibus or to the rear of the automobile. The gas in the bag is connected with the induction pipe, and the engine is worked by the suction process in the same manner as the ordinary gasoline vapor induction.

The principal disadvantage to the use of coal gas for automobiles is the bulky container necessary for the gas. The use of gas for small cars has proved unsatisfactory by reason of the problem of adequate space for storage. A suitable cylinder for containing compressed gas is said to be necessary for the general usage of such fuel for motor cars, and the probability of the continued utilization of coal gas as a substitute for gasoline appears to depend upon facilities for storage or compression.

The Submarine and Kindred Problems

The thousands of suggestions and plans presented to the Naval Consulting Board for assisting the Government in the present emergency indicate the patriotic fervor of the mass of our citizens.

The board makes a careful examination of every proposal presented. To facilitate this work, by suggesting the elimination of impractical ideas, the board calls to the attention of those who desire to assist it some of the popular misconceptions as to certain fundamental principles which are most frequently misunderstood by the layman.

A careful consideration of the following statements issued by the Naval Consulting Board in their Bulletin No. 1 will greatly simplify the work of that board.

ELECTROMAGNETS AND MAGNETISM

The electromagnet, the magnetic needle, permanent magnets and magnetism have been carefully studied for many years, and the laws governing their application may be found in any book on the subject.

Although these laws are generally known and applied in a practical manner in a multitude of devices in common use, even the man of wide experience will be astonished at the limited range of practical effect of electromagnets of large size. For instance, the magnets used in our manufacturing plants for lifting heavy masses of iron or steel are designed to exercise maximum magnetic effect, and for operation require a very considerable amount of electrical energy; yet a magnet which can lift 20 tons when placed in contact with an iron plate of that weight, will not lift a 2-in. cube of iron or steel if separated from it a distance of 2 ft. Therefore, proposed devices which depend on the attractive power of magnets for their operation in deflecting or arresting torpedoes, mines or submarines, must be governed by the simple laws of magnetism. A torpedo weighing approximately 2,500 lb., and traveling at a speed of 25 to 45 miles an hour, will not be deflected to any practical degree by any known application of magnetism; and it is not believed that an enemy torpedo, mine or submarine will ever be found in a position to be interfered with effectively by any electromagnetic means, however powerful.

ELECTRICAL EFFECTS IN GENERAL

There is a general misconception regarding the "electrification" of water and the atmosphere. There is no known method of "charging the sea with electricity," or "shooting a bomb of electricity," or of "charging the atmosphere with electrocuting current." Suggestions along these lines should show evidence that the writer has made research in the laws governing the application of electrical energy, and should contain sufficient proof of their feasibility to insure serious consideration.

On the other hand, applications of the transmission of electrical energy by means of alternating or pulsating currents—as used in wireless systems, for example—belong to a different class of electrical development.

Inventive genius is rapidly improving apparatus of this type for the sending and receiving of signals and messages, and the possibility of valuable results in this field is unlimited.

PROTECTION AGAINST SUBMARINE ATTACK

This subject, which is occupying the public mind as is no other, divides itself into a number of problems, the most important being the following:

(a) Means of discovering the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack.

(b) Protection of cargo-carrying ships by nets, guards and screens.

(c) Protection through decreasing the visibility of vessels.

(d) Methods of destroying or blinding a hostile submarine.

Submarines, to operate most effectively, must approach within close range of the vessel which is intended to be torpedoed. The installation of offensive weapons on the merchant marine has increased the necessity for the utmost care being exercised by the submarine commander in remaining unseen by the officers on the vessel to be attacked.

Reports from abroad indicate that in many cases submarines must have remained along certain lanes of travel for periods extending into weeks of waiting, with the expectation of torpedoing certain vessels. Under certain favorable conditions, where the waters are less than 200 ft. in depth, a submarine might lie at rest on the bottom, and if equipped with sensitive listening devices attempt to detect the approach of a vessel. As soon as this evidence was secured the submarine might come to the surface for a quick observation by means of the periscope, and in this manner obtain the proper aim which would be required to register an effective hit.

In case the water is more than 200 ft. in depth a submarine must be kept in motion to obtain steerage way in order to hold its proper depth of submergence. This speed may not exceed 4 or 5 miles per hour, but to remain submerged, and at the same time unobserved, the water must be at least 60 feet deep.

The latest type of submarine which is being used abroad has a surface speed of at least 17 knots per hour and a submerged speed of probably less than 10 knots. The superior gunfire from the merchantman which has been properly equipped would make it necessary for the submarine commander to obtain his observation, such as would permit accurate aiming of the torpedo, during the very brief interval of time required to come to the surface for observation through the periscope, and to again submerge.

If running near the surface, the periscope might be raised, a quick observation taken, and lowered again within 30 seconds. If, however, the submarine is on the surface, and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances.

A submarine of recent type probably has a total radius of action of as much as 8000 miles when traveling at a moderate cruising speed of from 10 to 11 knots, and may remain away from its home base for as much as one month without requiring either fuel or other supplies during this period.

This type of submarine may have as many as three periscopes, two conning towers, and two rapid-fire guns attached to the upper portion of its hull.

The vessel is steered by very efficient gyroscopic com-

passes, which are unaffected by extraneous magnetic or electrical influences.

A general understanding of the capabilities of the modern submarine for offensive operations will make it easier to appreciate the importance of the three problems which follow:

MEANS FOR DISCOVERY

The Aeroplane.—When the condition of sea and air are favorable, a submarine is readily discernible from an aeroplane flying at a sufficient height even though the submarine be submerged to a considerable depth.

While aeroplanes have thus been used successfully in the English Channel, they are unable to fly far out to sea where the submarines are now most active. Mother ships for carrying and launching aeroplanes might be used in this connection, but there are only a small number of such ships in operation and the construction of others under present conditions is necessarily a slow process.

Various sound-recording devices, intended to locate surface-vessels, submarines, and even moving torpedoes, are now being carefully tested. Water is an excellent conductor of sound, and the development and improvement of such apparatus offers a promising field for inventive endeavor to those who possess adequate scientific training and laboratory facilities.

Many devices are suggested which depend upon optical means of detection, such as special forms of telescopes and field-glasses to be mounted on ships, or on scouting vessels. Many special forms of searchlights and projectors have been suggested. The fact that a moving torpedo leaves in its wake a stream of air-bubbles caused by the exhaust-air from its propelling engines, offers, under favorable conditions, one means for discovering the approach of a torpedo. This evidence is, however, difficult to detect in a rough sea or at night, and, furthermore, the bubbles do not reach the surface of the water until after the torpedo has traveled onward a distance of from 50 to 200 ft. toward its target.

The dragging of trawls, or nets, by special guard-boats, not only with the view of locating submerged submarines, but also to sweep up floating and stationary mines, is frequently suggested. Under certain conditions this operation is practicable and effective.

It will be seen that each of the above methods, however useful, has its limitations, and scientists and inventors should apply themselves not only to the task of improving these, but also of finding supplementary methods and devices.

PROTECTION OF CARGO-CARRYING SHIPS BY NETS OR SCREENS

Many designs of such devices are suggested, and most of them are intended to be attached to the hull of the vessel to be protected. Many other suggestions along these lines, and differing only in some of their minor characteristics from the foregoing, have been received by the Board. Up to the present time not one of these proposals involving screens of any kind has received the approval of the Navy Department or of the Merchant Marine. The principal objections offered to these devices are that they are heavy, difficult to hold in position, unmanageable in a heavy sea, and that they interfere with the speed and with the ability of the vessel to manoeuver. The undeniable evidence which has been accumulated during the past few months of submarine activity has demonstrated that the immunity of a vessel to submarine attack is dependent very largely on its speed and also its manoeuvering ability. The percentage of vessels having speeds of 15 knots or more which have suffered from submarine attack is very small, while the losses of slow vessels, whose speed is less than that of a submerged submarine, is practically one hundred per cent of those attacked. Many of the suggested devices would prevent the launching of life-boats or rafts from the vessel to be protected. It is barely possible, however, that there may be developed some form of this general plan which will be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board.

PROTECTION THROUGH INVISIBILITY

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can only be determined by observing its smoke, which floats high in the air. Improved smokeless combustion is therefore desirable. Relative invisibility may also be afforded by methods of painting. Suggestions as to any other methods of reducing the range of visibility will be of interest.

DESTRUCTION AND BLINDING OF THE SUBMARINES

A rapid-fire gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The powerful effect of any submarine explosion on all neighboring bodies provides a simple means of destroying or crippling an undersea boat. Once it has been even approximately located, the setting-off of a heavy charge of high explosive, well submerged in the vicinity of the submarine, will bring about this result.

In certain areas a quantity of heavy, black petroleum or similar substance which will float on the surface of the water has proved an effective means of clouding the optical glass in the periscope's exposed end.

Under favorable conditions of wind and position, many vessels have saved themselves from torpedo attack by the production of a smoke screen. This may be formed either by incomplete combustion of the oil used for fuel by most naval vessels, or it may be created by burning chemicals, such as phosphorus and coal tar, or mixtures in which these or other materials are used.

After hiding itself from the submarine in a cloud of dense smoke, the vessel, if possessed of sufficient speed, may be able by a quick manoeuver to change her position and escape before the submarine is able to discharge a torpedo.

MINES FOR NAVAL OPERATION

Ever since the first use of gunpowder in the prosecution of war, mines and torpedoes have received great attention both from the warrior and the inventor. Mines are either fixed or floating. The fixed or stationary submarine mine is fired by contact, electricity, timing device or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by especially equipped mine-laying vessels. Such a mine is provided with an anchoring device.

Floating mines differ from fixed mines in that they are unanchored, and, unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must, according to laws of war, be designed to become inoperative within a few hours after being set adrift.

TORPEDOES FOR NAVAL OPERATIONS

The modern submarine torpedo is about 20 in. in diameter and 20 ft. in length; is self-propelled; is not steered by magnetic means, and keeps a fairly accurate course for several thousand yards at an average speed of more than 30 miles an hour. Its weight is approximately a ton and a quarter, and, when traveling at normal speed, possesses great momentum—in fact, in one case, when the high explosive charge in the "warhead" failed properly to detonate, the body of the torpedo penetrated the steel hull of the ship attacked. Torpedoes are also provided with means to more or less effectively cut through screens, nets, or guards placed in their path.

A torpedo is projected from a submarine or other vessel by means of a special form of tube or gun. A small charge of gunpowder or compressed air is employed to start the torpedo, after which—if of the usual self-propelling type—it is driven through the water by its own compressed air motor, the air being supplied from a strongly built reservoir within the body of the torpedo itself. The torpedo is kept upon its course by a gyroscope steering mechanism, which is immune to outside magnetic disturbances.

The detonation of the torpedo is accomplished through a mechanism placed within its warhead, and if the torpedo is either abruptly diverted from its course or is checked in its forward motion the firing device, which is operated by arrested momentum rather than by any form of a projecting firing-pin, instantly ignites the heavy charge of explosive contained within the warhead. The explosion, if it takes place within 20 ft. of the vessel, will usually rupture the ship's plating, because of the terrific blow transmitted through the water from the point of the explosion to the ship's side. The depth at which a torpedo travels may be regulated and is usually between 12 and 15 ft. below the surface.

CONFINING THE SUBMARINES

The question as to why submarines are not destroyed before they reach the open sea is a most natural one, and the best answer which it is possible to give according to the officers of our navy and those of the foreign commissions who have visited this country, is as follows:

The submarine bases are very strongly protected by land batteries, aeroplanes and large areas of thickly mined waters extending to such distances that the largest naval gun cannot get within range of the bases. In spite of these protections, there is now going on a continuous attempt on the part of the Allied navies to entrap or otherwise defeat the submarines as they emerge from the protected areas. Nets are laid and as promptly removed by the enemy, whose trawlers are in turn attacked by our destroyers. The design of these nets and the detailed arrangement of their fastenings and attachments offer a broad field for invention, but it should be remembered that they must be capable of being used in waters in which there is a tidal current running from two to five miles per hour. Many suggestions for "bottling up" these bases have been offered, but, as will be realized, it is not desirable to publish information which would indicate even in the smallest degree this country's plans.

SHIPS AND SHIPBUILDING

Many suggestions are made for ships of unusual form to provide for safety in case of a torpedo or mine exploding near or against the hull. Most of these plans are an elaboration of the usual watertight bulkhead construction now required as structural design for all modern ships. The multiplicity of watertight compartments in any hull design tends to add to the vessel's safety. The modern tank steamer used to carry fluid cargoes, such as petroleum products or molasses, is a good example of this design, which has been in general use for many years.

The explosion of a nearby submarine mine or torpedo frequently tears great rents in the ship's plating, in some cases opening a jagged hole 10 ft. or more across, but the destructive effect on the hull of a ship caused by the explosion of a mine or torpedo may be greatly diminished by special hull construction.

From recent experiments and experience it has been demonstrated that the average merchant steamer may be seriously damaged by the explosion of a torpedo 35 ft. away from its hull, but the destructive effect at any given distance from the point of explosion depends to a large extent upon the design and condition of steel framing and plating. A vessel with a strongly built hull can withstand an explosion that would destroy a weaker vessel.

INSTRUCTIONS TO THOSE OFFERING SUGGESTIONS

A very large proportion of the letters and plans that are received describe devices or schemes which are obviously impracticable, or which show no novelty or improvement as compared with existing methods. After the elimination of these, the more meritorious inventions are submitted to the various standing committees of the board for examination. If an invention receives the approval of a standing committee, it is presented to the board, with a favorable report, and if then again approved it is forwarded to the Navy Department with the indorsement of the board.

By means of the condensed information contained in bulletins it is hoped that inventors and others who wish to present matters for examination will cooperate with the board by analyzing their own inventions. The board will thus be enabled by this help to spend a larger part of its time in the development of inventions, plans, or devices which are believed to be promising of assistance to the Government in prosecuting the war.

Presumably the Government intends to pay for inventions which it adopts, but as yet no specific provision has been made by law for this purpose.

Petroleum Marketed in 1915 and 1916.—The petroleum marketed in the United States in 1915 amounted to 281,104,104 barrels, having an average value of $0.638 per barrel, according to the Geological Survey. In 1916, 330,899,868 barrels were marketed, having an average value of $1.10 per barrel. The increase in quantity was 6.99 per cent and the increase in value was 84.38 per cent.

Henry Marion Howe's Work in the Evolution of Metallography*

BY DR. ROSSITER W. RAYMOND

The genesis of a new science or branch of science is on this wise:

First, there is the invention of some new means or method of investigation, such as the chemical laboratory, the telescope, the microscope, or the spectroscope, followed at once by an innumerable host of startling, confusing, mostly qualitative observations. Such an invention reveals to mankind a dazzling but vague new world, the very existence of which was scarcely suspected before, and the indefinite outlines of which inspire poetic generalizations and vast hypotheses; beautiful, if true—beautiful, indeed, irrespective of their truth.

Then comes the long period, less thrilling yet not less meritorious and even more important, during which the means and methods of observation are rendered more precise, and the recognition of differences more minute. At the same time, the older data are revised, corrected and sorted; many, probably most, of them being rejected. This is the stage of preparation of the raw material of the science; and it is characterized in every science by the accumulation of a well-nigh intolerable burden of distinctly separated facts. But this burden must be patiently borne, and the separate units of which it is composed must be delimited, measured and weighed, in order that the mathematical, that is, the quantitative, character may be impressed upon them.

Illustrations of this principle will occur to all who have followed the growth of any science.

General Myer, the creator of our U. S. Weather Bureau, once told me that when he began to organize that service at Washington, he found in the garret of the Smithsonian Institution tons of old papers, containing "weather observations," contributed by public-spirited citizens all over the country, who had heroically got out of bed at certain hours to read their thermometers, rain gages and weather-cocks and anemometers. But nobody had tested or standardized their apparatus, and nobody guaranteed its freedom from accidental aberration or mischievous meddling.

I have heard also of a great German mineralogist who made many thousand measurements of crystals and based upon their varying angles some beautiful hypotheses. But after his death, another mineralogist tested his goniometer, and found in it defects which vitiated his observations.

Such are the pseudo-materials of science, which must be got out of the way before safe induction can begin. But even really scientific data may present, during the stage of verification and inchoate arrangement, an overwhelming complexity which threatens to smother a new science in its cradle. Take, for instance, the condition of biology before Wallace and Darwin Everybody was furiously busy detecting differences, and founding upon them the definitions of new species, and the mere catalogs of species were beyond the student's comprehensive grasp. We all remember the universal sigh of relief with which the scientific world, welcoming the Darwinian hypothesis as its new guide, began to study similarities and relationships, instead of differences, and saw the incalculable multitude of individual species group themselves in a grand order, illuminated by a new law.

This emergence of a general formula from a chaos of equations marks the final stage in the genesis of a science. That is not the end, but only the beginning, of its history. It must still grow by accretion, subdivide by fissile separation, and establish its relations to other sciences. And at every step the operations of observation, verification, criticism, analysis and synthesis must be repeated, just as the embryo rehearses in miniature the history of a species.

It follows that the stages of development which I have indicated, though they may seem, on the large scale, to follow one another, really go on, *pari passu*. There is no time at which any one of them ceases. Yet with regard to a single and limited branch of scientific inquiry, their existence and succession may be clearly discerned.

It is my difficult but honorable and welcome task to set before you an outline of the work of a master who has contributed mightily to all these phases in the growth of the new science of metallography: as a discoverer and observer; as an industrious compiler; and as the builder of a noble edifice out of the materials thus gathered and prepared.

Henry Marion Howe was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (from 1824 to 1830) and later for his labors in the instruction of the blind. His mother was Julia Ward Howe, author of the Battle Hymn of the Republic, and leader in many reforms. It was a good stock on both sides, making him heir to intellectual keenness and refinement, the capacity for both enthusiasm and perseverance, a passion for the pursuit of knowledge, and a gift of clear and felicitous statement.

This inheritance was improved by a liberal education. No matter how vehemently the business or scientific value of a "college course" may be controverted, I notice that, without exception, the successful men who have had such a course are glad they had it, and those who have not, wish they had. We may be sure that Prof. Howe's easy command of his field in technical literature owes much to the circumstance that he was graduated in 1865 from the famous Boston Latin School, and, four years later, received his degree as Bachelor of Arts from Harvard College. Thus equipped, he entered the Massachusetts Institute of Technology, which gave him in 1871 the degree of "Graduate in the Department of Geology and Mining Engineering"—a cumbrous title for which the institution substituted, a few years later, that of "Bachelor of Science." And Harvard made him Master of Arts in 1872, and Doctor of Laws in 1905.

But upon this basis of wide and liberal culture, it was necessary to his future achievements that he should lay another foundation of acquaintance with practice; and this he did during the next dozen years, as a student in the steel works at Troy, manager of works at Pittsburgh, and designer and builder of the works of the Orford Nickel and Copper Co. at Capelton and Eustis in the province of Quebec, and at Bergen

*An address, very slightly abstracted, made at the presentation of the John Fritz Medal to Professor Henry M. Howe, on May 10, 1917. From the July *Bulletin* of the American Institute of Mining Engineers, which also contains the addresses by Dr. Hollis and Dr. Sauveur and the reply of Dr. Howe, as well as a very interesting list of the many publications by Professor Howe.

Point, New Jersey. His experience in the metallurgy of copper bore legitimate fruit in the publication at a later period of his first book, "Copper Smelting"; but before this appeared (in 1885) he had already become known through his technical papers as an acute observer and reasoner, by no means averse to friendly controversy.

Since it is my present duty to offer, not so much a symmetrical and complete account of Prof. Howe's activities as a description of the particular labors in recognition of which he receives today from his brother engineers the John Fritz gold medal, I shall pass lightly over the general features of his career, merely observing that from 1883 to 1897 he resided at Boston, and, besides his private practice as a consulting metallurgist and expert witness in metallurgical patent suits, was lecturer on metallurgy at the Massachusetts Institute of Technology; that in 1897 he was called to the professorship of metallurgy in Columbia University, from which position he retired in 1913 with the title of Professor Emeritus; and that for the last ten years he has declined as far as practicable all professional business in order to devote himself exclusively to the completion of what had clearly become the great scientific mission of his life. To this end he has maintained at his own expense a special laboratory of research.

It gives me pleasure to fancy, whether or no the fancy be also fact, that I remember the beginning of that mission, forty-odd years ago. In 1871, the first year of the existence of the American Institute of Mining Engineers, Mr. Howe, then just graduated from the Massachusetts Institute of Technology, became a member of the new organization. His two earliest contributions to its Transactions, "Blast-Furnace Economy," in Vol. III, and "Thoughts on the Thermic Curves of Blast-Furnaces," in Vol. V, indicated already that he was making a scientific study of practice. But between the dates of these papers a famous controversy was inaugurated in the forum of the Institute by the brilliant paper of Alexander L. Holley, *primus inter pares*, entitled "What Is Steel?" In this controversy eminent metallurgists like Wedding, chemists like Prime, and expert captains of industry like Metcalf, vigorously took part; but of all the knights of the tourney none rode a straighter course or laid in rest a sharper lance than Howe, whose paper on "The Nomenclature of Iron" ardently advocated a scientific as distinguished from a commercial nomenclature. To tell the truth, the battle had a commercial origin. The real question at issue was not, What *is* steel? but, What may fairly be called steel at the custom-house? And the technical reputation of the Institute was invoked by one party in favor of a convenient, practical industrial classification which would relieve importers from the expensive refinements of science.

Well, there was even an International Committee on the subject, and the Committee made a Report, and the Report was not adopted by the Institute, except provisionally for optional use in its publications, because the Institute was wisely deemed to be an arena of discussions and not a tribunal of decisions. Never was a more fortunate position assumed, for the great question was left open, as it should be always. The tariff difficulty was adjusted somehow; the antagonists shook hands; the thunder of the captains of industry and the shoutings died away. But one man continued the inquiry fiercely in his own soul. Henry Marion Howe, before whom the dust of the controversy loomed like a giant Afrite still defying attack, devoted his life thenceforward to the mighty conundrum, What is Steel? That he has spoken the last word—even his own last word—on the subject, no one would venture to say; but certain it is that he has brought us to a degree of knowledge the very existence of which was scarcely dreamed in 1876.

It is curious that at that time he insisted upon the capacity of steel for hardening as an essential element in classification. For it was through this door—the study of the conditions and nature of the hardening process—that the advance was to be made into the wider field of knowledge. And the instrument of knowledge was to be the new science of metallography.

That science, at least so far as it relates to iron and steel, may be said to have begun with the observations of Sorby on the microstructure of iron, reported in 1864 and 1868. Martens published independently in 1878. But already in 1868 Tschernoff had enunciated the chief laws that govern the metallography of iron. These were supplemented by the appearance in *Stahl und Eisen*, 1885, of Brinell's laws. All these creditable steps of progress were rendered more or less uncertain and incomplete by the imperfection of the apparatus and methods of precision, by consequent errors of observation, and by gaps in the data—though the aggregate quantity of material was already overwhelming. Then came, in 1887 and subsequent years, the remarkable investigations and intuitions of Floris Osmond, who discovered that metals frequently combine to form definite chemical compounds, and that these compounds frequently form solid solutions. He discovered also the thermal critical points of iron, and, interpreting these changes in the cooling-curve as indications of some molecular change, propounded the brilliant hypothesis of the allotropy of iron which furnished the acceptable allotropic theory of the hardening of steel. To him, as Prof. Sauveur remarks in his Biographical Notice of Osmond (*Trans.* (1913), 45, 274), we owe likewise the discovery of austenite, the non-magnetic solid solution of iron and carbon existing above the thermal critical range, and the transition-constituents, martensite, troostite and sorbite, marking as many distinct and important steps in the transformation, on cooling, of the solid solution austenite into the ferrite-cementite aggregate.

This brings us to the date of Howe's first book on the subject; and the history of the new science, as I have already sketched it in general terms, is epitomized in the essays and books of Prof. Howe from the appearance of his "Metallurgy of Steel" in 1888 to that of his "Metallography of Steel and Cast Iron" in 1916. The first of these books was an amazing accumulation of reported facts, tabulated, verified and explained as far as was then practicable. The last is an equally amazing array of facts, but now sifted, tested, logically arranged and luminously interpreted, exhibiting not uncomprehended differences, but significant similarities and relationships. The first was a heap, parts of which had been sorted; the last is an edifice. To produce the first required intelligent and inexhaustible industry and critical discernment. The second exhibits the creative genius of an architect. Between the two lies the history

of a science, to every stage of which this builder has made some important contribution. Let me mention a few of these, under the heads of invention of improved methods; discovery of new facts; testing of data; and correlation and interpretation of observed phenomena. I shall not pretend to comprehensive completeness in this survey. I must be content with the exhibition of typical samples.

One of the new methods invented by Prof. Howe is that of determining the microstructural and other conditions which exist in steel at high temperatures by fixing those conditions through the process of quenching—a method which has been generally adopted, and by the use of which much clearer and more trustworthy results have been obtained than were formerly possible.

Among his discoveries of new facts may be mentioned the isotropy of the effects of plastic deformation (announced in 1888, and supported in 1914); the possibility of effacing blowholes in soft steel by welding (1909); the relations of graphite flakes in cast-iron, representing, not complete discontinuities of the metal, but only the filling by graphite of the interstices in ferrite skeletons; and the crystallography of the slip-planes ("Metallography of Steel and Cast Iron," 327).

But this investigator kept himself acquainted with the discoveries of others. In 1893 he confirmed by rigorous experimental proof the brilliant hypothesis of Osmond that the transformations in steel represent the alternate acquisition and loss of hardening capacity.

Under the head of testing and verifying data I would name the rigorous analysis of the so-called Clapp-Griffiths process; the demonstration that the chief benefit of rolling and forging is due to the low finishing temperature rather than to the degree of mechanical reduction, as formerly believed; and the striking demonstration that the results of one of the most important investigators of the gas evolved from iron were wholly vitiated by the leakage of the apparatus. All these may be found in the "Metallurgy of Steel," which contains also analyses of the conditions of dephosphorization; of the chemistry of the crucible process, and of the technique of Bessemer practice.

In a remarkable paper on the structure of steel, contributed to the proceedings of the American Society for Testing Materials for 1911, Prof. Howe collected into the form of propositions or laws the observed relations of heat treatment to the microstructure and mechanical properties of steel. In that paper he enunciated twenty-three of these laws; and had he then ceased from his labors, his work would have followed him as an imperishable record indelibly carved upon the history of science. But he was destined to go still further during the five years which followed. His latest book, "The Metallography of Steel and Cast Iron," published in 1916, occupies intellectually a higher plane than its predecessors, by which I mean that it commands a wider outlook, permitting grander generalizations, and the recognition, in due perspective, of causes, effects and relations. This book, in short, exhibits that simplification which I have described as following the stage of maximum complexity in the development of a science. Its very title, coupling steel with cast iron, expresses the maturer view which includes both in one continuous series, subject to the same laws—a significant conclusion of the controversy which began with the contention that steel was not cast iron. Not that the difference has been disproved, but that a higher unity has been shown to embrace it. Such is indeed the normal end of controversy—"peace without victory" through agreement on a higher level.

This book is not a text-book, repeating what is generally accepted already. Covering the field in which others have meritoriously labored, it propounds, suggests and prophesies new truth and new views of truth. It is a product of the two kinds of genius, the genius which consists in an infinite capacity for taking pains, and the genius which with happy intuition surveys, divines, coordinates and interprets the cosmos in the chaos.

That my estimate of the work of our great American colleague, as summed up and set forth in this book, is not merely an expression of personal affection or patriotic pride, let me prove by one or two opinions from eminent authorities.

I would quote first a few paragraphs translated from a review of the book by Prof. Le Chatelier in the *Revue de Metallurgie* (Vol. 13, No. 2, March-April, 1916):

"The new work of Mr. Howe is entirely original. It has nothing in common with the numerous treatises on metallography which have appeared during the last ten years. Whoever has read one of them has read them all. Here we have to do with the personal observations and views of the author. As he indicates in his preface, he has written this treatise, not to state the solidly established principles of a young science, but to cause the creators of that science themselves to think; to open before them new horizons. Hence he has not feared to announce theories sometimes a little hazardous. . . .

"This study will make an epoch in the history of the progress of science. It represents many years of uninterrupted research, but for a much longer period it will certainly be consulted by investigators with fruitful results."

The following remarks are taken from a similar review by H. C. H. Carpenter, Professor of Metallurgy at the Royal School of Mines, South Kensington, England.

"It is quite safe to say that Prof. Howe's book will at once take its place as an authoritative, and, indeed, classical, exposition of the field of knowledge with which it deals. From whatever standpoint it is judged, it is a great book—great in its power, lucidity, balance, comprehensiveness, and pre-eminently scientific character."

In a private letter, written with reference to the announcement that the John Fritz medal was to be conferred upon Prof. Howe, the same distinguished author says that he believes no award could have given greater pleasure to the metallurgists of Great Britain, who look upon Prof. Howe, not merely as the *doyen* of metallographists in America but as their most distinguished representative; "a worker whose single-mindedness in the pursuit of truth is an example to us all, and whose conscientiousness gives to his publications a character of their own."

Finally, I take the liberty of quoting from a private letter received by me from a no less eminent American, Prof. Albert Sauveur himself, who, as the President of the Board of Award, bestows this medal to-night:

"Prof. Howe, in his recent masterly book on the metallography of steel and cast iron, reviews exhaustively and examines critically, as he alone can do, every

view at all worthy of recognition, dealing with the subject he covers. I believe that any responsible author who has ever expressed a reasonable opinion on any subject dealing with the metallography of iron and steel will find his views recorded and discussed in this book. Prof. Howe then proceeds to weigh with great fairness and extraordinary intelligence and lucidity the arguments or evidence supporting the different views, and draws his conclusions accordingly. His method is that of a mathematician solving a problem in which each factor is given its proper value. In this way Howe has rendered to metallurgists an inestimable service; and he alone could render it. Where most of us could see only chaos and obscurity, he is able to bring order, and to discover the light that, under his skillful manipulation, soon illuminates the darkest corners. . . .

"This, I think, is his greatest achievement—the marvellous coordination which he has brought into the science of metallography through his genius and his labor, tremendous in quantity, marvellous in lucidity. To him more than to any one else we owe the quick rejection of weak or ill-supported theories, in favor of the survival of the fittest—a process so necessary to the advance of any branch of human knowledge."

To these expressions of individual and representative opinion should be added the numerous formal honors bestowed upon Prof. Howe by institutions and governments in many lands. England, France and Russia have each conferred three of these recognitions, while others have come from Germany and Sweden. And, last but by no means least to his patriotic heart, come two announcements, received since I began the preparation of this address: the one, of his election as a member of our National Academy of Science; the other, of his selection as one of the charter members enumerated in the proposed Act of Congress incorporating the American Academy of Engineers.

Thus the applause of two continents attends the act of the John Fritz Medal Committee in selecting Henry Marion Howe as a recipient of that great honor. And the act has also another significance. It is a recognition on the part of engineers that the microscope and the test-tube have become the tools of engineering. Indeed, when we remember that the strength of materials is the alphabet of every branch of engineering science represented by the givers of this medal, we must admit that the man who with microscope and test-tube analyzes the causes and determines the conditions of that strength is among the greatest of engineers.

While this testimonial is bestowed by engineers, I cannot forbear to utter my satisfaction that it is received by one who is more even than an engineer; whose many-sided patriotic and literary activity is typical of this age, in which engineers are, as St. Paul said of the Gentiles, "no more strangers and foreigners, but fellow-citizens with the saints." If we may say of him, as Johnson said of Goldsmith, *"non tetigit quod non adornavit,"* we may almost add, *"non est, quod non tetigit."* And so we crown to-day with grateful pride, not only the leader, but also the comrade and friend!

A committee from the House of Representatives headed by Congressman Dent of Alabama has been appointed to investigate the circumstances surrounding the recent shipments of defective ammunition to American forces in France.

Italy Fixes Maximum Prices of Coke

The "Gazzetta Ufficale," published at Rome, July 30, 1917, contains a decree of the Minister of Industry, Commerce and Labor concerning the maximum selling price for gas coke, according to a recent number of "Commerce Reports," and which should be interesting to coke makers and consumers, in the light of recent American Developments.

From Aug. 1 to Sept. 30, 1917, the maximum selling price of gas coke for immediate delivery or C. O. D. at factory is fixed as follows: (a) Coke, large, 280 lire ($54.04) per ton; (b) powdered, with mesh, 293.50 lire ($56.65); (c) nut coke, 152 lire ($29.34); (d) coke, bulk cargoes without mesh, 255 lire ($49.21).

The communes are to fix a moderate superprice for the sale and delivery of these goods ex-factory in their territory.

Persons selling gas coke at prices higher than those established, plus any communal superprice that may be fixed, will be fined 200 or 300 per cent of the entire price received from such illegal sales. Repeated offense will render the offender liable to one year's imprisonment in addition.

In case a dealer, producer, or any other seller refuses to sell gas coke at the established maximum prices, plus the communal superprice, the prefect, or if necessary the syndic, may sequester the goods and cause them to be sold at the expense of the holder, for whom, however, the amount necessary for his own consumption will be reserved.

Australia's Restrictions on Tin Plate

The Minister for Defense prohibits (unless the written consent of the director of munitions has first been obtained) the use of tin plates for the manufacture of containers or the tops and bottoms of cardboard containers for the following goods: tobacco and cigarettes; boot polish; confectionery, except boiled sweets; powders of all descriptions; soaps, except liquid soap; spices; dry pharmaceutical preparations; linoleum polishes, and metal polishes; or for the manufacture of the following goods: Crown seals; bird cages; toys; advertising boards and signs; fancy canisters, and letter boxes.

This order does not apply to tins already manufactured, but holders of stocks of tins used for containers as specified were required to render immediately to the director of munitions a return showing the quantity of each class of tin on hand at the date of the order and their average monthly consumption of each class of tin, such return to be verified by statutory declaration.

Any person who uses tin plate in contravention of the order is declared to be guilty of an offense against the war precautions act, and is liable to punishment by a fine not exceeding £100 or imprisonment for a term not exceeding six months, or both.

In the case of dry foodstuffs for export, military, or Red Cross purposes, favorable consideration will be given by the director of munitions for applications for exemption from the requirements of the order, but the position regarding stocks of tin plates is such that even with regard to these requirements every endeavor must be made to make cardboard or other similar containers suffice.

The Synthesis of Ammonia and the Oxidation of Ammonia to Nitric Acid*

By Edward B. Maxted, Ph. D., B.Sc.

The direct production of ammonia from its elements is at the present time a subject of peculiar interest, not only by reason of the conditions under which the reaction is carried out in practice, but also because it constitutes the most economical method available, if the initial difficulties are once overcome, of fixing atmospheric nitrogen.

It has long been known that on leading a mixture of nitrogen and hydrogen over certain catalysts, such, for instance, as iron or manganese, small traces of ammonia are produced even at atmospheric pressure, while in conformity with the well-known principle of Le Chatelier, the equilibrium ammonia-content for a given temperature is increased by carrying out the reaction at an elevated pressure, the use of a pressure furnace for the synthesis of ammonia having been described, for instance, by Jost early in 1908.

We are, however, almost exclusively indebted to the pioneer work of Haber for the discovery of catalysts which become active at comparatively low temperatures and therefore under conditions such that the ammonia content of the reaction mixture is raised to values sufficiently high to render possible the commercial utilization of the synthesis, while the subsequent development of his methods by the Badische Anilin und Soda Fabrik constitutes a most remarkable example of the introduction of modern physico-chemical methods into commercial life.

Despite the fact that no less than about 1,000,000 tons of synthetic ammonium sulphate per annum is being manufactured by the Badische Anilin und Soda Fabrik in Oppau near Ludwigshafen, the published information regarding the process is extremely scanty. For this reason it may perhaps be of interest to give some description of the work undertaken and results obtained by my own company towards the establishment of a technically sound foundation for a synthetic ammonia industry in Great Britain.

The first step in the industrial synthesis consists in the choice and adoption of suitable methods for the manufacture of nitrogen and hydrogen. The formation of ammonia is extremely sensitive to the presence of even minute traces of inhibitive substances, and it is therefore absolutely essential for the success of the reaction that these component gases be obtained not only as economically as possible, but also in a state of practically absolute purity, and above all free from catalyst poisons of every nature. While methods exist for the direct production of a nitrogen-hydrogen mixture, these in general tend to give a gas containing an appreciable quantity of catalytically poisonous carbon monoxide, and for this reason we find that it is not only simpler, but also more satisfactory from an economic standpoint to manufacture our gases separately and to mix them in the proper proportions as and when required.

The most economical method for the manufacture of pure nitrogen is undoubtedly that of low temperature separation from air. We utilize for this purpose the Pictet process, according to which air, cooled by exchange and by other means down to, but not below, its liquefying point, is injected, in the gaseous condition and at a pressure approximately equal to atmospheric, into a separating column (see Fig. 1) over the plates of which a descending current of liquid nitrogen is allowed to flow. This liquid nitrogen exerts an analyzing influence on the air to be separated, in that it permits the passage upwards, as a gas, of the nitrogen of the air, while atmospheric oxygen is condensed by the current of liquid nitrogen and flows as a liquid nitrogen-oxygen mixture into the lower part of the column, where it undergoes continuous fractionation in such a way that it reaches the reservoir at the bottom of the separating column as liquid oxygen practically free from nitrogen. It will thus be seen that, in the process which we employ, only one-fifth of the air to be separated is liquefied, the nitrogen being kept in a gaseous condition during the separation and only a small fraction being subsequently liquefied in order to maintain the flow of liquid nitrogen, necessary for separation, over the plates of the column.

This subsequent liquefaction of a small proportion of the nitrogen produced is carried out in two ways, namely, in the first place by slight compression in closed coils contained in the oxygen reservoir and on the plates of the column, a suitable pressure for liquefaction being obtained by the use of a small compressing system, of such a nature that the pressure in the various coils can be adjusted to correspond with the temperature obtaining in the particular portion of the column in which the coil in question is situated. Thus

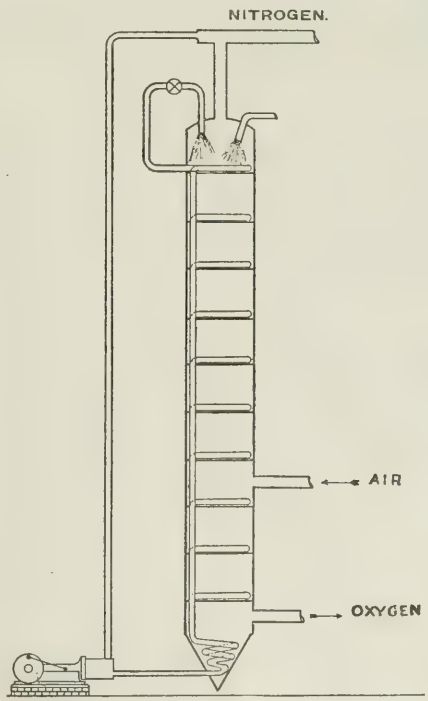


FIG. 1—PICTET PROCESS FOR NITROGEN

*A paper presented at the annual meeting of the Society of Chemical Industry in England and published in the Journal of the Society, July 31, 1917.

a coil at the top of the column where the temperature is —196 deg. C. would require only a very slightly increased pressure to induce liquefaction of the nitrogen contained therein, while a coil in the oxygen reservoir at the bottom of the column, at a temperature of —182 deg. C. must be supplied with nitrogen at a pressure of several atmospheres, the latent heat of liquefaction in the coils supplying the heat by means of which the mixture on the lower plates of the column is fractionated.

Losses of cold due to radiation and imperfections of exchange are compensated by the liquefaction by expansion of a further quantity of nitrogen, this forming the second source of the separating liquid referred to above.

The system described has been installed on a scale giving 400 cubic meters of nitrogen and 100 cubic meters of oxygen per hour and has proved extremely satisfactory both from the point of view of the purity of the gases produced and by reason of the abnormally low power required for operation as compared with other systems.

Passing from the manufacture of nitrogen to that of hydrogen, it will be seen as the result of even superficial calculation that the cost and purity of hydrogen constitute the key to an economical synthesis of ammonia.

Rejecting electrolytic hydrogen on account of its high cost, there exist various methods of preparing hydrogen in a more or less pure condition from water gas. By the so-called continuous method, water gas and steam are passed together over a catalyst, consisting usually of activated iron oxide, when by the interaction of the carbon monoxide of the water gas with the steam, the carbon monoxide is replaced by an equal volume of hydrogen according to the equation:

$$CO + H_2O \rightleftarrows CO_2 + H_2$$

The carbon dioxide thus produced is absorbed by compression on water, hydrogen sulphide and other impurities being removed by iron oxide purifiers of the usual type. It is found in practice, however, that the above reaction is never complete, however great the excess of steam, and that the hydrogen produced contains considerable quantities of carbon monoxide, which is of course not absorbed by the ordinary purifiers. This may be eliminated by treatment with calcium carbide, or by compression on heated soda lime with the formation of formates.

The same objectionable presence of carbon monoxide occurs in hydrogen prepared by the low temperature separation of water gas, by reason of the very appreciable vapor pressure of carbon monoxide even at temperatures approaching its solidifying point.

Carbon monoxide is also found in hydrogen manufactured from water gas by the intermittent process, *i.e.*, by the alternate steaming and reduction of iron. It occurs in this method of hydrogen production owing to the instability of carbon monoxide at high temperatures, which decomposes according to the equation $2CO \rightleftarrows CO_2 + C$. The carbon produced is deposited on the iron contact mass during the reducing phase and reacts with the steam subsequently introduced, with the reformation of carbon monoxide during the steaming operation, this carbon monoxide contaminating the hydrogen, thus: $C + H_2O = CO + H_2$.

We find, however, that the intermittent method, which in its usual form gives hydrogen containing from 1 to 2 per cent of carbon monoxide, may be modified in such a way as to give hydrogen of the high purity of electrolytic hydrogen, the cost remaining approximately the same as for the ordinary impure water gas hydrogen, by utilizing for reduction, instead of water gas, a gas containing sufficient carbon dioxide to prevent the separation of carbon according to the above equation. This reducing gas is obtained easily and cheaply by a modification in the method of manufacturing the water gas.

We obtain in this way hydrogen completely free from carbon monoxide and containing as its sole impurity only a little nitrogen, while by suitable modifications of the method of manufacturing even this nitrogen content may be brought down in such a way that hydrogen of 99.9 per cent purity and even higher, is produced directly from water gas without any subsequent purification, save that afforded by an iron oxide-lime purifying box of the usual type. This complete elimination of nitrogen is, however, of course not necessary for ammonia, but is desirable where the hydrogen is to be used for other purposes; for instance, for the hardening of fats.

The following typical analyses illustrate the purity of the hydrogen produced by our process, sample 1 being manufactured without special precautions against nitrogen content, sample 2 with such precautions:

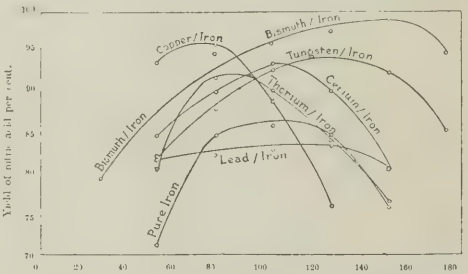
	Sample 1, Per Cent	Sample 2, Per Cent
Hydrogen	99.81	99.94
Carbon monoxide	0.00	0.00
Carbon dioxide	0.00	0.00
Nitrogen	0.19	0.06
	100.00	100.00

For the synthesis of ammonia itself, nitrogen and hydrogen, mixed in the proportions required, are compressed to a high pressure in order to increase the equilibrium value for ammonia at the temperature at which the catalyst becomes active, this pressure having as its second effect a very considerable increase in the reaction velocity of ammonia formation.

Since the power required for the compression of a gas from a pressure, P_1, to a second pressure, P_2, is given by the equation:

$$W = k \log \frac{P_1}{P_2}$$

while the equilibrium ammonia content for a given temperature varies approximately directly as the pressure,



Velocity of passage of gas mixture in litres per hour (at room temperature) per c.c. of free space in catalyst chamber.
Temperature = 700 deg. C.
Each c.c. of free space = 20 sq. cm. of catalytic surface.

FIG. 2—OXIDATION OF AMMONIA

it follows that from the point of view of compression economy, it is advantageous to work at as high a pressure as is compatible with the strength of materials and smoothness of operation. It is not, however, possible in practice to work at a much higher pressure than 200 atmospheres, and we find 180 atmospheres to be a very suitable working pressure. The very considerable increase in reaction velocity at increased pressure is, further, an additional reason for the use of as high a working pressure as possible.

The catalysts which are available for the promotion of the synthesis, neglecting rare metals of the platinum group, consist of uranium and iron. Uranium, while capable of giving decidedly higher yields of ammonia per passage than iron, possesses the drawback of being only prepared and regenerated with difficulty and of being rapidly rendered inactive by traces of water or of air in the reacting gases.

For this reason we find it preferable to employ, as is done in Germany, iron containing traces of other bodies as promoters, taking advantage especially of the cumulative action of two or even more promoters contained simultaneously in the catalyst.

In view of the lack of published results as to the actual percentage of ammonia obtained in practice from iron catalysts, the following typical figures from the relation between the time of contact of the nitrogen-hydrogen mixture with the catalyst and the ammonia percentage for an iron-potash catalyst may perhaps be of interest. The third column gives the yield of ammonia in kilos, per hour per cubic foot of catalyst space, provided that the ammonia formed is totally removed in the course of circulation, a condition which may be very nearly approached by employing a refrigerator almost at the solidifying point of ammonia (—77 deg. C.) with a rate of circulation such that the ammonia percentage in the gas is not too low. The temperature in this case was, as is usual, not uniform throughout the catalyst column, but varied from about 650 deg. C. at the beginning of the column to about 600 deg. C. at its end.

Time of Contact with Catalyst	Ammonia in Gas, Per Cent	Yield of Ammonia in Kilos. per Hour per Cu. Ft. of Catalyst Space
13 seconds	0.8	6.46
26 seconds	1.4	3.03
66 seconds	2.7	2.33
105 seconds	3.1	1.78
18 minutes	3.7	0.89

The most economical rate of working practice will, from the point of view of power, not necessarily be that at which the highest yield of ammonia per hour is obtained, but will be modified by the efficiency of the heat and cold interchangers and by the completeness of the elimination in the refrigerator of the ammonia formed.

Since the method employed for the complete conversion of the compressed hydrogen-nitrogen mixture into ammonia consists in passing it alternately over the heated catalyst and through this refrigerating system respectively, with alternate formation of a certain percentage of ammonia and its removal in a liquid condition, the cost of operating the process, starting with the compressed gases, consists therefore of the supply of and abstraction of sufficient heat to compensate for radiation and for the deficiencies of the heat and cold exchangers, the efficiency of the heat exchanger being very considerably increased by the by no means negligible heat of formation of ammonia itself. For the economic efficiency of the process too great care cannot therefore be paid to the construction of the exchangers connected with the heated reaction vessel and with the refrigerator respectively.

The maximum temperature which can be employed in the refrigerator is determined by the ammonia content of the gas to be separated, and by the pressure at which the synthesis is being carried out, it being necessary, since the first portions of the ammonia are formed more rapidly than successive increments, to effect as complete as possible a removal of all ammonia formed before re-passing the residual gases through the catalyst column. The following table gives the percentage of ammonia theoretically left in a gas at 150 and 200 atmospheres respectively after passing through a refrigerator at the temperature shown:

Temperature, Deg. C.	150 Atm., Per Cent	200 Atm., Per Cent
0	2.7	2.1
—10	1.9	1.4
—20	1.2	0.9
—30	0.76	0.57
—40	0.47	0.35
—50	0.25	0.19
—60	0.13	0.1

The construction of the ammonia retorts presents considerable difficulty not only on account of the high pressure, together with a temperature approaching a red heat, but especially by reason of the rapid deterioration of the wall of the vessel under the influence of the ammonia mixture at elevated temperatures. In order to reduce this undesirable effect to a minimum the reaction vessel may be constructed of a material as resistant as possible to the action of ammonia and surrounded by a nitrogen jacket at the same pressure as that to which the nitrogen-hydrogen mixture in the catalyst chamber is subjected, the whole being surrounded by a wall capable of resisting the pressure, or other precautions must be taken so that the wall which bears the pressure does not become weakened. The manner in which a retort bursts, when this undesirable accident occurs, is a matter of considerable interest to the operator. A burst (as distinguished from an explosion due to admixture of air) results, as far as our experience goes, in a clean split, unaccompanied by fragments. We, nevertheless, take every precaution against accidents, especially with full sized retorts, by placing the reaction vessels in pits preferably out of doors.

The choice and adoption of a suitable method of heating is by no means easy. Electric heating presents drawbacks in practice, some of which are not apparent on theoretical grounds and for this reason a system of heating has been adopted in Germany according to which air is injected into the catalyst chamber in such a way that the requisite reaction temperature is reached and maintained by internal instead of external combustion. The method possesses the advantage of making possible the use of retorts which are simple in construction, but is, on the other hand, somewhat liable to give rise to explosions owing to incomplete combustion of the comparatively small amount of air necessary to maintain the temperature, this air, if not burnt, by reason of a too low temperature in the retorts or for other reasons, accumulating throughout the entire plant until a mixture results containing oxygen in proportion sufficient for explosion. We ourselves have

given very considerable attention to the subject of the most suitable methods of heating, and are adopting a system which seems to combine simplicity of working with a high degree of safety.

Passing to a short consideration of the economic side of the process, the cost per ton of synthetic ammonia may be summarized from a point of view of energy in the statement that about 5½ tons of fuel suffices both for the production of the necessary hydrogen, and for the generation of the power required for nitrogen production, for compression, circulation, refrigeration, etc. The labor factor in the process is small, but on account of the comparatively high initial cost of the plant, the dead charges per ton of ammonia work out at rather a high figure. The cost of synthetic ammonia under normal conditions in this country should work out at about £10 to £12 per ton.

The synthetic ammonia, when produced, has for the majority of uses to be fixed as an ammonium salt by means of a suitable acid, or it may be oxidized to nitric acid, which may itself, if required, be used for ammonia fixation. It is at present usual to fix ammonia as the sulphate, either by direct neutralization or by interaction with other sulphates, such as calcium sulphate, without the use of free sulphuric acid.

Ammonium nitrate possesses certain advantages by reason of its high nitrogen content and particularly because no extraneous acid is necessary for its manufacture. It is, however, deliquescent and for this reason cannot be transported in sacks.

The oxidation of ammonia to nitric acid in presence of platinum was discovered by Kühlmann as long ago as 1830. The process has, however, only become of technical importance since its development by Ostwald, who in 1902 proposed as a catalyst compact platinum covered with platinum black, the ammonia and air being led over the catalyst with a high velocity in order to minimize decomposition of the oxides of nitrogen formed by the oxidation.

The process, as carried out at the present day, takes three forms:

1. Oxidation by means of a platinum plug (Ostwald's process).

2. Oxidation by means of an electrically heated platinum net.

3. Oxidation by means of base metal catalysts.

According to the Ostwald process a mixture of air and ammonia is passed along a heat interchanger at the end of which a platinum plug is situated. The yield is good, averaging 90 per cent or even higher, but the regulation of temperature is not so easy as in the second type of platinum plant in which electrical heating is employed. The main Ostwald patent has now expired. The use of an electrically heated net of compact platinum is finding increasing favor and presents many advantages over a plant of the Ostwald regenerative type.

It may be preferable at this stage, instead of discussing the various more or less well-established plants employing platinum, to illustrate briefly the results which are obtainable with base metal catalysts taking, as typical examples of these, catalysts consisting of iron containing various promoters, and considering for the present only binary mixtures. The present war restrictions prevent a full description being given of the exact plant and conditions used for the oxidation, but the results about to be described show most decidedly that satisfactory results may be obtained without the use of platinum. We employ for the oxidation of ammonia not only air but also air enriched with the oxygen obtained as a waste product from our nitrogen plant, or even pure oxygen, the slightly increased cost of materials being more than compensated by greatly increased output and by other even more important factors.

The activating influence on iron of certain bodies such as bismuth or copper was well known at the time we began working in this direction, and the results obtained during preliminary tests with known catalysts amply justified a systematic study of the activation of iron for the oxidation of ammonia. Thus ammonia, mixed with ten volumes of air (containing sufficient oxygen for complete oxidation) gave in a preliminary experiment a yield of nitric acid equal to 90 per cent of the theoretical.

The results shown in Table I were obtained at 700 deg. C., the ammonia being supplied with an amount of oxygen sufficient but not in excess of that required for its complete oxidation to nitric acid.

It will be seen on referring to Fig. 2 that the efficiency of pure iron for the oxidation of ammonia is very appreciably raised by the addition of cerium, thorium, bismuth, tungsten, or copper, the time of contact necessary for the maximum yield of nitric acid varying, as would be expected from the complicated nature of the reaction, with the particular promoter used. For instance, the optimum of contact is, for the conditions employed, about 0.01 second for bismuth-iron, 0.015 second for cerium-iron, and 0.02 second for iron-thorium. Lead exerts a curious flattening influence on the curve, the yield of nitric acid being almost independent of the time of contact.

Antimony, from its relation to bismuth, might have been expected to exert a similarly high activating effect. On testing this, however, transitory high results were obtained (91 per cent yield with a time of contact of 0.02 second), but probably owing to the volatilization of antimony oxide from the seat of reaction, a curve was obtained, after running for some time, more or less agreeing with that for pure iron.

The alkali metals as typified by potassium hydroxide appear to have little effect on the activity of iron, while calcium was found to depress very considerably the maximum yield of nitric acid, the same effect being obtained with zinc and with manganese.

Passing to a consideration of the economic side of the manufacture of nitric acid by the oxidation of ammonia, it will at once be seen that by virtue of the high speed of passage of the reaction gases over the catalyst, a relatively small catalyst chamber will suffice for the oxidation of a comparatively large amount of ammonia per hour, and that, secondly, since practically no power is required for the operation, the actual conversion costs, exclusive of that of the materials necessary, will be low. The power required for the production of 1 ton of nitric acid from ammonia should not exceed 0.015 kilowatt-year, exclusive of the cost of condensation and of concentration, a process which we are carrying out economically without the use of sulphuric acid.

Finally it may be of interest to compare, from a point of view of power, the relative efficiencies of the

TABLE I

Catalyst	Time of Contact in Seconds	Yield of Nitric Acid Per Cent
Iron	0.03	71.0
"	0.02	82.5
"	0.015	83.5
"	0.012	82.5
"	0.01	75.0
Iron-thorium	0.03	79.0
"	0.02	88.5
"	0.015	87.3
"	0.012	82.0
"	0.01	75.6
Iron-cerium	0.03	82.5
"	0.02	87.0
"	0.015	90.0
"	0.012	87.0
"	0.01	79.0
Iron-bismuth	0.06	78.0
"	0.02	90.0
"	0.015	92.0
"	0.012	93.1
"	0.01	94.6
"	0.00086	91.0
Iron-tungsten	0.03	80.3
"	0.02	85.2
"	0.015	89.3
"	0.012	89.0
"	0.01	89.0
"	0.00086	83.0
Iron-copper	0.03	90.0
"	0.02	92.0
"	0.015	86.0
"	0.012	75.0
"	0.01	68.0
Iron-lead	0.03	80.0
"	0.02	80.4
"	0.015	81.0
"	0.012	81.4
"	0.01	81.8
"	0.00086	79.0
Iron-antimony	0.03	80.5
"	0.02	82.0
"	0.015	82.5
"	0.012	78.8
"	0.01	75.0
Iron-potassium	0.03	75.0
"	0.02	81.0
"	0.015	83.0
"	0.012	82.0
"	0.01	77.4
Iron-uranium	0.03	77.5
"	0.02	81.0
"	0.015	82.0
"	0.012	78.5
"	0.01	77.0
Iron-calcium	0.03	36.0
"	0.02	58.0
"	0.015	64.0
"	0.012	63.0
"	0.01	57.0
Iron-zinc	0.06	51.0
"	0.03	62.0
"	0.02	67.0
"	0.015	60.0
"	0.012	37.0
Iron-manganese	0.03	51.0
"	0.02	65.0
"	0.015	75.0
"	0.012	79.0
"	0.01	76.0
"	0.00086	69.0

three most important methods for the fixation of atmospheric nitrogen, namely, the arc process, the cyanamide process, and the direct synthesis of ammonia from its elements.

In making such comparison it will be seen that in the arc process electrical energy alone is involved, while for the direct synthesis of ammonia a mixed requirement of coke (for hydrogen production, steam generation, etc.) and of power (for compression, etc.) is involved. Thus in order to obtain comparative figures it is necessary to translate the coke and other fuel required per ton of fixed nitrogen into units of power. The power equivalent of 1 ton of coke or coal is the number of units of electrical power which that ton of fuel would be capable of producing if it were utilized for that purpose under efficient conditions. This may be taken at 1500-1600 kilowatt-hours or 0.18 kilowatt-year.

By the arc process 1 kilowatt-year of power will produce about 600 kilos. of nitric acid or 130 kilos. of fixed nitrogen. For the production of 1 ton of fixed nitrogen (as cyanamide) by the carbide-cyanamide method, about 2 kilowatt-years of power, plus 3 to 3½ tons of coal and other fuel are required, making a total power (converting coal into kilowatt-years as above) of 2.6 kilowatt-years per ton of fixed nitrogen. In other words, 1 kilowatt-year by the cyanamide process will fix 380 kilos. of nitrogen as compared with 130 kilos. by the arc process.

Turning to the power required for the direct synthesis of ammonia, 6½ to 7 tons of fuel (coke and coal) are required for the generation of the necessary hydrogen and for the production of all power required for the fixation of 1 ton of nitrogen as ammonia, including the separation of the nitrogen itself from the atmosphere. Converting fuel into power, as before, about 1.2 kilowatt-years are required for the fixation of 1 ton of nitrogen by direct synthesis of ammonia. Thus 1 kilowatt-year will fix about 830 kilos. of nitrogen, compared with 380 by the cyanamide method and 130 by the arc process.

These figures clearly show that from the point of view of power and material the direct synthesis of ammonia is more than twice as efficient as the cyanamide process, and more than six times as efficient as the arc process.

These striking results are modified slightly by the difficulty in operating the direct synthesis and by the cost of labor, which is lighter than for cyanamide, together with the necessary dead charges, which are heavier.

The direct synthesis of ammonia, on the other hand, accompanied where necessary by the subsequent oxidation to nitric acid, presents by far the most economical method of fixing nitrogen at present known, and if only by virtue of the urgent need of the land for cheap, abundant, and non-seaborne fertilizers, deserves every attention from a standpoint of national economy.

Effects of Fuel Shortage in Neutral Countries.—Shortage of fuel, which, according to Commerce Reports, is daily growing worse in the Scandinavian countries, induces extraordinary efforts at economy, not so much for the purpose of saving money as for the conservation of the total fuel supply to last through the indefinite period of famine. All the governments, State and city, are doing their utmost in the way of regulations and limitations on the travel in trains, trams, and automobiles and in the use of coal, wood, coke, and gas for cooking and all other purposes. The demand for more economical steam boilers and engines, and for oil and gasoline engines, heating plants, and domestic cooking apparatus is greater than ever before.

In Copenhagen all kinds of apparatus for economical cooking are being tried, including small, cheap forms of charcoal burners adapted for short blocks of hardwood. Several forms of fireless cookers (locally known as "hay boxes") are being extensively tried.

One of the important interests affected by the coal shortage in Denmark is the manufacture of cement. These works are now closing down, and this will cause disturbance in the building trades, which are already hampered by the shortage and high prices of materials and labor. Thus house room becomes scarcer and rents advance.

Synopsis of Recent Metallurgical and Chemical Literature

Electric Smelting of Iron Ores in Northern Sweden.—A recent issue of the "Jern-Kontorets Annaler" reproduces in a slightly abridged form a memorandum drawn up by Mr. J. A. Leffler, in which he investigates a proposal to install electric furnaces in the north of Sweden for smelting pig iron. The committee recommended the installation of four plants with six furnaces in all to produce 65,000 to 70,000 tons of pig iron per annum, using from 110,000 to 120,000 tons of ore and about 25,000 tons of charcoal.

In his investigation the author makes, among others, the assumption that to smelt one metric ton of pig iron from the Luleä or Gellivare ores, 1.6 ton of ore and 0.4 ton of charcoal are required, and 0.272 kw.-year of electric current. As explained by him in detail, such a low consumption of current can only be attained by installing four furnaces of a total of 9000 kw., one as a receiver unit and three working continuously. This would make it possible to utilize 92 per cent of the purchased power, while with one furnace only the useful percentage would only be 83 per cent, which is the average result attained during the three years' working in 1913-1915 at the "Jern-Kontoret's" experimental plant at Trollhättan.

The capital outlay at Luleä would be about $417,000 for the plant itself and about $102,000 for dwellings for officials and workmen, while for Gellivare the corresponding figures would be $460,000 and $114,000 respectively. There would be six officials and seventy-five workmen with their foremen, and the assumed output at each place would be 30,000 metric tons (33,100 short tons) per annum. For the cost of production of one metric ton of electric pig iron the author submits the following estimates:

Estimate of Costs of Producing One Metric Ton of Pig-Iron by Electricity

	At Gellivare	At Luleä
800 kg. ore } 800 kg. briquettes }	$4.44	$5.25
Limestone	.16	.10
400 kg. charcoal	5.07	4.40
0.272 kw.-year	3.51	4.95
Electrodes	.45	.40
Repairs and maintenance	.89	.81
Wages	1.58	1.32
Management and sundries	.55	.47
Royalty	.34	.34
Sinking fund	.87	.79
Rents	1.40	1.32
Freight to Luleä	1.18	....
Total cost	$20.44	$20.15

The freight from Luleä to Gävle and unloading the iron into railway cars would cost $1.09 per ton. It will thus be seen that the northern pigs would cost at Gävle about $21.40 per ton, and therefore could not compete with the pig iron obtainable there from the blast furnaces at $17.50 to $19.00 per ton for basic, and at $19.00 to $20.25 per ton for acid open-hearth pig iron.

Nitric Acid

Nitric Acid from Coal Gas—Hausser Process.—In the *Chemical Trade Journal and Chemical Engineer* for July 14, 1917, is given a short account of a process developed by Professor Hausser for making nitric acid direct from coal gas by igniting with a high tension spark. A large-scale experimental plant is stated to have been at work before the war at the Nuremberg gas works.

The explosion of the gas is effected in steel vessels surrounded by a water jacket, to which, in the original plant, air and gas were admitted under pressure through separate valves. Ignition of the charge then takes place by means of a high-tension spark derived from a magneto attached to one side of the vessel. The magneto is connected with, and driven from, the same mechanism as operates the valves.

The chemical reactions involved in the process are of a particularly simple nature. The nitrogen combines with oxygen to form nitric oxide: $N_2 + O_2 = 2NO$. The nitric oxide mixtures are then cooled and passed into a gas holder, where the necessary time is allowed for oxidation to take place on the following lines: $2NO + O_2 = 2NO_2$. The nitrogen peroxide formed by oxidation is finally sent forward to counter-absorption vessels, where, reacting with water, it gives rise to the formation of a mixture of nitric and nitrous acid as follows: $2NO_2 + H_2O = HNO_3 + HNO_2$. The nitrous acid is then oxidized to nitric acid by an excess of oxygen. In this way the acid obtained varies in strength from 30 to 50 per cent., and the weak product is in most cases evaporated and redistilled in order to provide a concentrated solution. The waste gases from the plant, still containing some nitric oxide, are treated in special washing towers, in order to recover the greatest possible quantity of the nitrous products. Generally from 2 to 3 per cent of the original nitric oxide gas is discharged with the waste products.

It is explained that, so far as can be ascertained, the original plant has now been considerably modified, particularly as concerns the explosion chamber, and the efficiency of the latest apparatus is such that expectations have been surpassed. In its new form, the plant consists of a battery of chambers or bombs, all of which are supplied from two compressors, while instead of the gas and air being compressed together the two are dealt with separately. It is essential that a high temperature should be attained during explosion, and to this end the air, after compression, is passed through a specially designed preheater operated by gas. For reasons of temperature, again, a small proportion of pure oxygen is regularly mixed with the air in the compressor. The latest form of container is fitted with four valves, driven by gearing from an electric motor, and it is the speed of this motor which determines the number of explosions per minute. It is essential that rapid cooling of the waste products should be effected, otherwise there is a tendency for the nitric oxide to undergo decomposition, and a special exhaust valve is employed for the purpose of temperature drop. Immediately on the outlet of the bomb is attached a condenser coil submerged in water, and in this coil the water resulting from combustion is thrown down and drawn off. It is customary to regulate the explosions, so that they occur in each bomb at the rate of about sixty per minute. Within limits, the greater the capacity of the bomb the larger will be the yield per unit of gas. The process is applicable to producer and all low-grade gases, and so far as the yield of nitric acid is concerned it has been shown that when employing coke-oven gas about 6¼ lb. of acid per 1000 cu. ft. of gas exploded must be looked upon as a maximum.

Manufacture of Synthetic Rubber from Carbide.—A communication from the Swiss Acetylene Association published in *Zeitschrift für Angewante Chemie* is

abstracted in the *Chemical Trade Journal and Chemical Engineer*, July 14, 1917. The manufacture of acetone with a view to the production of synthetic rubber is of considerable importance in Germany at present. The importance of this new industry is indicated by the fact that some of the largest firms in Germany, such as the Konsortium für elektro-chem. industrie of Nürnburg, the Elektrotech. Werke of Bitterfeld, Farbenfab. vorm. F. Bayer & Co., Griesheim-Elektron, and others, have been occupied with this problem for some years. There are firms in Germany producing 10 to 50 tons of carbide per day in order to convert the acetylene into acetic acid and acetone, the latter being intended chiefly for the production of synthetic rubber. This new industry should be of special interest to Switzerland, since the necessary carbide will in the future be available in large quantities in that country. After the war the export of carbide will be considerably reduced, and this product will therefore become much cheaper. On the other hand, the price of rubber will remain high for several years. In order to protect this young industry it is suggested that Switzerland should impose a duty on imported rubber, since the countries which export crude rubber will doubtless put an export tax thereon.

Physical Basis of Color Technology.—In the Journal of the Franklin Institute for July and August, M. LUCKIESH gives a very interesting and comprehensive discussion on the value of physical tests in color technology, with much practical data on pigments, dyes and glasses. In the introduction he says that a perusal of the literature on colored media and a general acquaintance with color industries have led to the conclusion that the chemistry of such substances greatly dominates the physics in color technology. In fact, much of the physics of color is so little used in some of these activities that it is either not generally understood by color-technologists or its value is underestimated. Spectral analyses, the quantitative determinations of the spectral characteristics of colored materials, provide the foundations for many important aspects of color technology, and without such data some work progresses more or less blindly. With such data, and those derived from less analytical methods, many interesting facts of color technology can be bared and various factors can be determined which are unapproachable from the viewpoint of chemistry or from ordinary inspection. The following extracts are interesting:

"Owing to the indefiniteness and limitations of the data yielded by most of the so-called colorimetric methods, and the difficulties attending the use of the monochromatic colorimeter at present, the paper is confined almost entirely to spectrophotometric data and their uses. Many instances arise when the degree of absorption for ultraviolet and infra-red rays is of interest. The former can be determined readily by spectrophotography and the latter by means of such energy-measuring instruments as the bolometer or thermopile. Other methods are available, which may readily be ascertained if necessary.

"For the purpose of the paper three classes of colored media are represented and discussed, namely, pigments, dyes and vitrifiable colors or colored glasses. Pigments are distinguished from dyes by their insolubility in their vehicle, while dyes are soluble. This distinction may appear arbitrary, especially in some cases; however, it is employed to some extent, and is a convenient classification. Pigments may be distinguished from paints in that the latter are pigments in a vehicle or medium. Vitrifiable colors are those which impart color to glass and to similar substances. Among pigments are found two general classes, one in which each particle is homogeneous, and the other in which a colorless base has been colored by depositing coloring matter upon it.

"The chief use of the data derived from such spectral analyses is that of establishing the spectral character of the pigment. The general value of such data needs no defence, for it is the actual foundation of the pigment as a coloring material. Its purity is thus established; its influence in color-mixture may be predicted; the purity or desirability of a color resulting from various mixtures of pigments whose spectral analyses are available may be predetermined, and in many ways such data are useful. It is quite beyond the scope of a single paper to discuss all the physical uses of such data; besides, it is the intention to confine the discussion chiefly to aspects which are likely to be less commonly appreciated.

"The mixture of dyes is governed by the same subtractive principles of color-mixture as the mixture of pigments, although the greater number of dyes and the more exacting or delicate applications of dyes in industries, in the making of accurate filters, etc., make their spectral analyses of perhaps more importance than in the case of pigments. Certainly a knowledge of the spectral characteristics of dyes, as in the case of pigments, makes for an ease and certainty in making, and in visualizing mixtures which cannot be enjoyed without such data. It is beyond the scope of this paper to present a complete discussion of the usefulness of spectral analyses of dyes or to present the spectral analyses of all the dyes available.

"The uses for spectral analyses of dyes are manifold, as in the case of any class of colored media. In general they provide a physical basis for systematic color-mixture, besides providing the necessary information for choosing dyes for many purposes. In many aspects of color-technology only the integral or subjective color is finally of interest, but the author cannot refrain from emphasizing that even in such cases an intimate knowledge of colored media and their mixtures cannot be attained without spectral analyses, and that the combination of dyes becomes systematic with such data available.

"With spectrophotometric apparatus well maintained, a complete spectral analysis can be made in about an hour, although there is much room for improvement in such apparatus which will result in the saving of time. However, this is not a serious matter, because for a given coloring material only one analysis need be made, as will be shown later, to provide information for all degrees of concentration or depth of solution. The author has available hundreds of spectral analyses which, after once obtained, are a perpetual source of information."

Electroplaters Establish Research Chemist

The American Electroplaters' Society is to support a chemist at the United States Bureau of Standards to do research work in electroplating, and have also appointed a committee at the request of the same bureau to assist in standardizing electro-deposits on war supplies.

Recent Metallurgical and Chemical Patents

Petroleum Technology

Synthetic Hydrocarbon Compounds. — Louis B. Cherry of Kansas City, Mo., patents a method of changing a low-gravity hydrocarbon compound into a compound of higher gravity and lower boiling point by the aid of electricity. The apparatus is shown in Fig. 1 and comprises a still 1, provided with a suitable

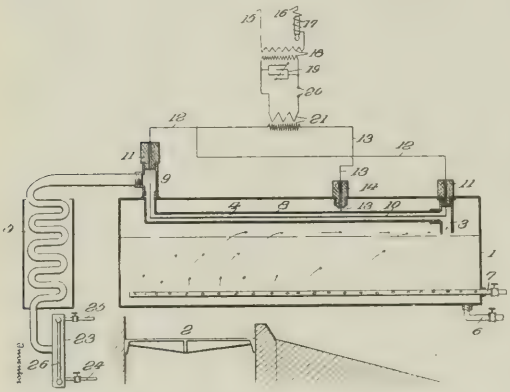


FIG. 1—DIAGRAM OF APPARATUS

heating means 2, and an offtake pipe 3. The treating chamber is shown at 4 and a condenser at 5. Fluid supply pipes are shown at 6 and 7, the latter for discharging a different fluid into the bottom of the still. The treating chamber 4 is made of metal or other good conductor of electricity. The wall 8 of the treating chamber forms one electrode, the other being shown at 10 extending through the tube.

The power is supplied through wires 15, 16, from any suitable source of preferably alternating current and is supplied to the wires 12, 13, through the medium and control of any suitable adjustable inductive resistance 17, any suitable high-tension transformer 18, any suitable adjustable condenser 19, any suitable spark gap 20, any suitable (either adjustable or non-adjustable) oscillation or high-frequency transformer 21, or otherwise, to produce a bipolar oscillatory high-frequency silent electric discharge across the treating chamber back and forth between the electrodes 8, 10. The current should be of such nature and so controlled as to avoid sparking or arcing and to provide the oscillatory silent discharge of high voltage and high frequency, and yet so that the current is under convenient manual control to permit varying the frequency thereof to suit the peculiar conditions that may arise during any operation and the particular hydrocarbon compound product desired.

If it is desired to raise the gravity and lower the boiling point of a comparatively low gravity hydrocarbon distillate of the paraffin series, the liquid compound is introduced into the still through the pipe 6 (if need be under the required pressure to overcome the pressure in the still), and the flow of liquid is controlled and is approximately constant to maintain the desired liquid level in the still as the liquid is vaporized in the still and passed off through the electric treating chamber. During the operation of the still, a constant flow of either free hydrogen or hydrogen carrying gas or compound is discharged into the liquid in the still through pipe 7. (1,229,886, June 12, 1917.)

Iron and Steel

Carborundum as a Carbon and Silicon Furnishing Agent.—A process of making cast iron from steel scrap by the addition of carborundum is patented by J. E. Johnson, Jr., of New York City. The process is described in the patent specification as follows:

"In carrying my invention into effect in utilizing steel-scrap, I melt down by any suitable and appropriate means, a quantity of steel-scrap so as to produce a molten bath of the same. Into this bath, I introduce and thoroughly mix therewith, a suitable quantity of carbid of silicon, preferably in amorphous form. As the carbid of silicon dissolves in the bath, the silicon will unite with the iron and will leave the carbon in the nascent condition, and in this condition the carbon will readily combine with the steel. The combination of the carbon and silicon with the steel is assisted by the fact that heat is developed by the disassociation of the constituent elements of the silicon carbid. It will be understood that I introduce sufficient carbid of silicon so that the final metal produced shall contain not less than 2 per cent and preferably 3 per cent of carbon, constituting cast iron.

"Instead of incorporating all of the carbon necessary, by the method of procedure just described, I may first introduce in the ordinary way into the bath of steel, as much carbon as it will readily take up, and then supply the remainder of the carbon necessary, and the necessary amount of silicon, by mixing carbid of silicon with the bath, in the manner described."

If it is desired to add phosphorous also, this can be done by charging the bath with a suitable phosphate, the result being that the silicon in the bath will reduce the phosphate so that it will combine with the metal. In this action the amount of silicon will be correspondingly lowered, and the necessary degree of carbonization will be effected without the presence of excessive silicon. (1,231,259 June 26, 1917.)

Ferroalloys

Production of Ferrosilicon in the Blast Furnace.—J. E. Johnson, Jr., of Hartsdale, N. Y., patents a process of producing ferrosilicon of high silicon content in the blast furnace. The process is described in the specification as follows:

In carrying my improved method into effect, I make use of a form of blast furnace, in a general way similar to that now universally employed for smelting ores, and I charge the same with ore and fuel in the usual and well known manner. I introduce at the base of the charge, through the usual twyers, a blast which is rich in oxygen as compared with the usual blast of atmospheric air, the result of which is the production of a much higher combustion temperature than is available in the furnace as ordinarily operated, and a correspondingly increased reduction of the silica. The reactions in this operation may be expressed by the following formula:

$$SiO_2 + 2C + xFe \rightleftarrows Fe_xSi + 2CO.$$

Where atmospheric air is employed in the blast there is about 3¾ times more by weight of nitrogen than there is of oxygen, and since, other things being equal, the temperature obtainable is inversely proportional to the weight of the products of combustion, the temperature produced is only about 1/3 as high as would be produced by a blast of pure oxygen. In other words, the nitrogen in such large proportions in the blast acts as a dead weight on the combustion and keeps the temperature down to such point that the reduction of silica is confined to limits in which the final product contains a comparatively small per cent. of silicon, rarely above 16 per cent.

By my invention, by employing a blast rich in oxygen the increased temperature of combustion is very marked, and if pure oxygen were employed the gain would be so enormous that it would greatly exceed the requirements for the end in view, and since the increase of temperature need be only about one-third higher than is now obtainable with the use of atmospheric air, I find it sufficient for my purpose to employ a blast in which the oxygen and nitrogen will be of equal weights, or in approximately that proportion. A mixture of this character is more economically produced commercially than pure oxygen, and such mixture is sufficiently rich in oxygen to obtain the temperature required, for the reduction of the silica on the desired increased scale, and for the creation of the amount of heat available at that temperature to bring about such reduction.

Ferro-silicon as most generally employed in metallurgy, contains about equal proportions of iron and silicon in order to enable it to combine under the most favorable conditions with the molten metal in which it is to be incorporated. A blast in which the nitrogen and oxygen are mixed in equal or substantially equal proportions I have found admirably adapted for producing that temperature of combustion which will bring about the reduction of the silica and iron in the proportions mentioned, and a blast mixture of this character may be economically and conveniently produced and with a far smaller plant than is required for a richer mixture or for pure oxygen. (1,231,260 July 31, 1917.)

Abrasives

Abrasives from Nephelin Syenite.—HERBERT T. KALMUS of Brookline, Mass., has patented a process of treating nephelin syenite (consisting principally of silicates of aluminium, potassium and sodium) for the production of aluminous abrasives. The patent is assigned to the Exolon Company, of Cambridge, Mass. The nephelin syenite is pulverized and dissolved in a digester. The dissolving operation is carried out by sulfitation with from five to ten times the weight of the silicate, of a two per cent water solution of sulfur dioxid. In the sulfiting operation most of the aluminium, sodium and potassium contents, and a considerable portion of the silicon content, are dissolved. The mass in the digester containing the insoluble residue is then fractionally desulfited by the introduction of steam. The first part of the desulfitation is carried on until all, or nearly all, of the silica in the solution, is precipitated, and then discontinued. This silica precipitate (which may be silica, silica hydrate, hydrated silica, silicic acid, or any similar compound of silica), together with the insoluble residue, is removed by filtration and the solution is then further desulfited to precipitate the aluminium content. The aluminium content is then filtered from the solution, leaving the sodium and potassium (or alkali) content and possibly a little iron in the solution as comparatively stable sulfites and bisulfites. The aluminium content is precipitated as a basic aluminium sulfite or similar compound, and is preferably dried and calcined at a moderate temperature to drive off the water content along with a certain excess of sulfur dioxid. The resulting product is a white powder containing SO_3 varying through wide limits in amount, depending upon the details of treatment, but averaging, as practiced by me, from 15 to 20 per cent by weight.

This process of treating sulfitable aluminium silicates to recover the aluminium content is described in detail in a patent to Kalmus, Savell & Blake, No. 1,148,092, dated July 27, 1915.

The calcined aluminium content, in the form of dehydrated basic aluminium sulfite, is then placed in an electric furnace and fused. During the fusion of the aluminium content, the fused mass is periodically withdrawn from the furnace and poured in thin streams to rapidly cool. The process of treating an aluminous material in an electric furnace and rapidly cooling the product during the fusion is described in a co-pending application Serial No. 26,626, filed May 7, 1915, for an electric furnace product and the method of making the same.

The fusion of the aluminium content of nephelin syenite is preferably carried out in an arc-type electric furnace which operates, in part, as an arc furnace and in part as a resistor furnace, such, for example, as the furnace specifically described in the British patent to Johnson No. 16,738 of 1896. (1,234,905 July 31, 1917.)

Osmotic Processes

Electro-Osmosis.—Several patents have been issued to BOTHO SCHWERIN, of Frankfort-on-the-Main, Germany, and assigned to the Elektro-Osmose Aktiengesellschaft of Frankfort-on-the-Main, Germany. One patent 1,230,524 June 19, 1917, relates to a method of separating substances in suspension in a liquid comprising adding a suitable electrolyte to the liquid and subjecting the liquid and the substance in sol-state therein to the simultaneous action of centrifugal force and an electric current. Another patent 1,235,063 July 31, 1917, relates to an electro-osmotic process for the separation of colloids, or, for instance, for separating the colloids and the dissolved bodies individually from a solution containing several colloids. The invention consists in subjecting the mixture to the action of an electric current in a circuit wherein are interposed one or more diaphragms the potential of which is so selected, that the constituent or constituents which cannot pass the diaphragm or diaphragms are separated, while the other constituent or constituents migrate through the diaphragm or diaphragms. By arranging several diaphragms of different charge capacity one behind the other, and desired separation of the constituents may be accomplished.

The diaphragms act in several ways. By means of indifferent diaphragms inserted in front of the poles, the electrolytes may be first eliminated. For example with an apparatus like that of Fig. 2 having the dia-

phragms 2, 3, made of parchment and a colloidal solution in the compartment between the diaphragms while the end compartments contain water the effect of passing an electric current through the solution is to separate the inorganic ions from the mixture, those of acid character migrating to the anode and those of basic nature to the cathode. The mixture may be impoverished, however, in acid or basic residues by separating the one or the other residue in increased proportion. For instance, by means of a positive diaphragm the

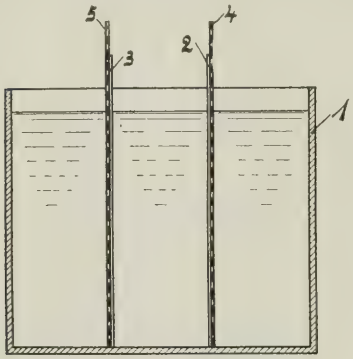


FIG. 2—ELECTRO-OSMOTIC DIAPHRAGM

acid, or by means of a negative diaphrabm the basic residues may be removed comparatively more quickly, so that in the mixture the electrolytes which are suitable for the desired separation may be retained in the correct degree of concentration.

Another patent 1,235,044 relates to a process for purifying glue, gelatine and similar products by electro-osmosis.

The process comprises subjecting to an electric current between two electrodes a mixture of a gelatinous substance with an electrolyte-dissociating liquid such as an aqueous glue solution, which is separated from each of said electrodes by one or more diaphragms of various degrees of permeability.

Slag Treatment

Recovery of Values from Slags.—A process for the recovery of values contained in slags is patented by J. B. Herreshoff, Jr., of New York. It is described in connection with the metallurgy of copper. Employing the apparatus illustrated in Fig. 3, 1 represents a smelting furnace. This produces, say, 60 per cent matte and the slag is run into a series of settling tanks 2, 3, 4 and 5. The tank 2 will contain the 60 per cent matte and tank 3 may contain 20 per cent matte, tank 4, 10 per cent and tank 5, 8 per cent. The

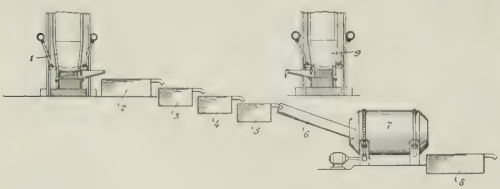
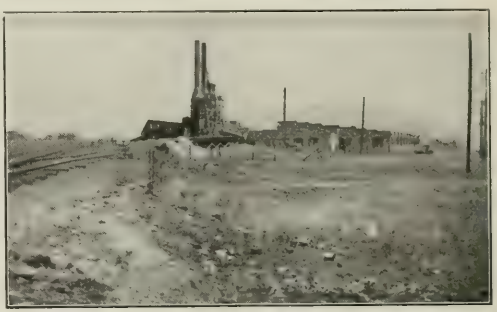


FIG. 3—ARRANGEMENT OF APPARATUS FOR RECOVERY OF VALUES FROM SLAGS

slag and matte from the furnace 1, discharges into the tank 2 and the slag separates out on top; this slag overflows and drops into the tank 3 and mixes with the 20 per cent matte and thus loses a part of its contained copper; after part of the contained copper, and with it, gold and silver is recovered in this manner. The slag then overflows into tank 4 and because of the still lower grade of matte in tank 4 a further removal of copper from the slag is effected. In like manner a further removal is effected in tank 5 and also in the long trough 6 down which, together with the purified slag, a still lower grade of matte, say 5 per cent, is run. This matte may be supplied by the smelting furnace 9. From the trough 6, the slag and 5 per cent matte discharge into the rotary mixer 7. The mixer may be of any suitable construction, preferably being provided, like the tanks and trough with a refractory lining, and may be rotated in any suitable manner. From the mixer 7 the slag and matte flow into the settling tank 8, from which the slag and matte may be drawn off separately. The process may be conducted wholly or partly continuously or intermittently. The low grade matte may be mixed sufficiently with the slag in one or more of the tanks 3, 4 and 5 and the resulting slag may be sufficiently free from copper for all practical purposes. Or the long trough 6 may accomplish the desired removal of contained copper without the tanks and the rotary mixer or a part of these elements. Or the mixer 7 may be used without the other elements. The tanks, trough, mixer and settling tank may be heated, as by the combustion of coal, charcoal or oil, so as to maintain the contents in liquid condition and preferably also so as to maintain a neutral or reducing atmosphere in contact with the materials being treated. The slag in the settling tank 8 will contain about 1 per cent of the percentage of copper in the settling tank matte in accordance with the general rule expressed above. (1,231,349 July 31, 1917.)

New Western Magnesite Plant

The accompanying illustration shows the new Spokane, Wash., magnesite plant of the American Fire Brick Co. Calcined magnesite and "magnesio-



MAGNESITE PLANT OF THE AMERICAN FIRE BRICK CO.

ferrite" will be made at this plant, the latter under patents issued to C. B. Stowe. The company has the northwestern rights for these patents and will use the magnesite from Stevens County, adding any desired percentage of iron.

A Gas-Fired Welding Furnace Installation

By Charles E. Richardson

Until recently welding has been considered impossible in furnaces with city gas. Without doubt, many actual difficulties have stood in the way, but not of an insurmountable character. The chief deterents to successful welding in gas-fired furnaces have been a number of rather vague theories and a large number of unsuccessful trials. When these failures were properly analyzed, the causes of failure could be readily seen and avoided, as will be explained in detail. The theories, when analyzed, disappeared, having no foundation.

Probably the most common of the theories was the belief that the chemical composition of the gas itself in some way rendered it unfit for use as a fuel for welding. The following may be cited as an example of the manner in which this particular theory tended to block the extension of gas in this fertile field. When the installation about to be described was first considered, a gas engineer connected with the job was very much opposed to any attempt to do the work, saying that the gas to be used did not have enough CO in it. Just what effect the CO was supposed to have could not be explained.

The belief of those designing the installation was that welding came about solely as a result of temperature plus a furnace atmosphere slightly reducing at all points. It was felt that the only relation the chemical composition of the fuel bore to the result was that it must be of such a composition as to yield a gas strong enough to give a flame temperature sufficient to make possible the securing economically of the temperatures required by the operation.

In analyzing the failures, it was found that, after excluding a few which were due to failure to obtain the necessary temperatures, the trouble lay almost without exception in the matter of furnace atmosphere. While the products of combustion issuing from the flues analyzed perfectly for the work, it was found that inside, at various points, anything but perfect conditions existed. This variation was caused by lack of suitable means for automatically proportioning and mixing. To explain specifically, the air and the gas, not having been homogeneously premixed in the correct proportions, entered the furnace through the several burners in a stratified condition. Molecules of oxygen and combustible had therefore to wander around in the furnace to find one another before reacting. This meant that the steel was exposed at very high temperature to free oxygen in spots and oxidization became active enough to make the operation impossible. Of course, the molecules of oxygen and combustible did finally meet and react and the flue gases therefore looked to be satisfactory, but they merely represented the sum total of the reactions. This condition of affairs showed conclusively that if satisfactory welding was to be accomplished, means must be secured to deliver to the furnace a homogeneously premixed and perfectly proportioned mixture of gas and air, and further that said means must be automatic, so that when the proportions were once set they would hold irrespective of the quantity of mixture supplied.

The designers, therefore, knowing that it was readily possible to secure the necessary temperatures, and that suitable proportioning and mixing devices could be obtained, and feeling that the theories regarding the chemical composition of the fuel were groundless, undertook the installation described below.

The design of the furnace is shown in Fig. 1.

It is made up of two working chambers, one 32 in. deep, 14 in. wide, and 10 in. high, and the other 48 in. deep, 20 in. wide, and 10 in. high, with a preheating chamber 48 in. deep, 12 in. wide, and 15 in. high between. The working chambers can be used separately

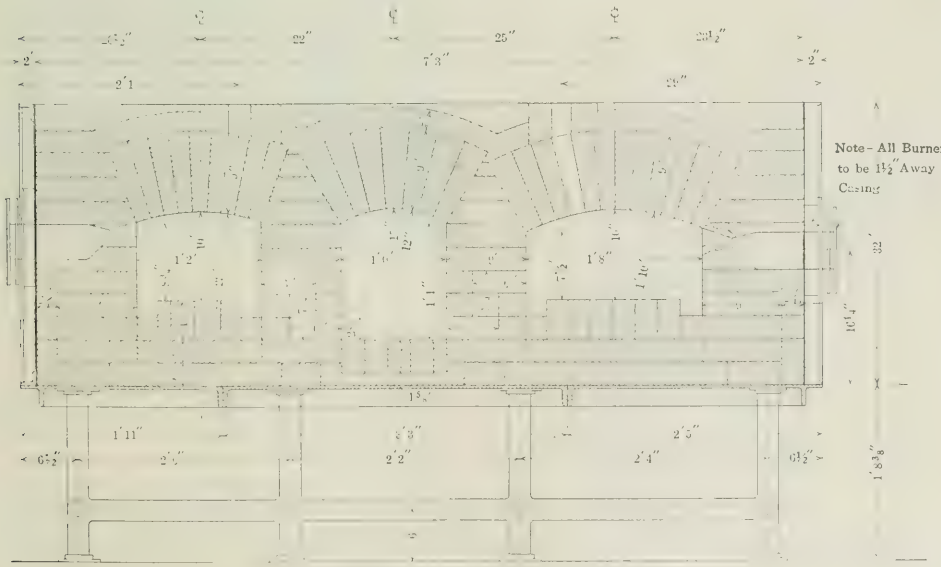


FIG. 1—TRANSVERSE CROSS-SECTION

FIG. 2—WELDING FURNACE IN OPERATION

or both together according to the size and amount of work to be handled. So far, one chamber has been found sufficient to handle the tonnage required. The flue gases from the working chambers pass into the preheating chamber and out the rear of same. The working chambers are held at a temperature of between 2700 deg. Fahr. and 2800 deg. Fahr. This yields a temperature of approximately 1800 deg. Fahr. in the preheating chamber.

The furnace is fired with Surface Combustion high pressure burners, and both quantity and quality of mixture is controlled by Surface Combustion high pressure control devices.

The furnace is used in the production of machine knives for rotary cutters of woodworking and other similar machines. The finished knives consist of a slab of soft steel with a thin layer of tool steel welded on one face. The dimensions of the stock used vary greatly; an average for the soft steel slabs would be 34 in. by 8 in. by $1\frac{1}{2}$ in.

The welding operation is as follows: A pile of eight or ten soft steel slabs is placed in the preheating chamber at the beginning of the day's run. When the desired temperatures have been obtained, one of these is placed in the work chamber after sprinkling the surface with borax. When heated to between 1900 deg. Fahr. and 2000 deg. Fahr., it is removed, the scale scraped from the surface and the tool steel strips placed in position flush with one edge and well sprinkled with borax. The piece is then replaced and brought to welding temperature. It is then again removed, welded under a power hammer and rolled to size. Often several reheats are necessary to finish the welding and rolling. The piece is allowed to cool after rolling, cut to size, hardened, tempered and ground to finished dimensions.

An illustration of the furnace in operation is shown in Fig. 2.

Because of the preheating and the reheats which vary greatly, it is impossible to state the efficiency of this furnace. The furnace handles 1700 lb. of work in nine hours on a consumption of 12,700 cu. ft. of 580 B.t.u. gas. These figures by no means represent the capacity of the furnace, but give an indication of the consumption of gas per ton of welded stock. The above figures are taken from a test made on the large working chamber. It is possible to at least treble the tonnage above indicated.

It was found that the mixture of gas and air, which gave the most satisfactory welds, resulted in a flue gas analysis as follows:

$CO_2 = 11.8$ per cent.
$O_2 = 0.0$ per cent.
$CO = 0.4$ per cent.

The theoretical CO_2 figured from an analysis of the gas used is 12.5 per cent, which checks closely with the above figures.

The installation has been in operation for several months and the following advantages over handling the same work by oil-firing have been found:

Quicker heating up, both of furnace and work, cooler and cleaner shop, increased capacity, better control of temperature and furnace atmosphere, less scale, easier to light up and operate—single valve control, and more constant composition and heating value of fuel.

The above-described furnace was designed and installed by The Surface Combustion Company of Long Island City, N. Y., at the plant of D. Lovejoy & Sons, Lowell, Mass. Gas is supplied by the Lowell Gas Light Company on a sliding scale basis, which makes gas available at a rate of approximately $0.70 per M.

Long Island City
New York.

New Design of Tong Hook for Removing Covers of Furnaces

A new type of lazy tong hook shown in the accompanying illustration has just been shipped to The Braden Copper Company by the Orenstein-Arthur Koppel Company, of Koppel, Pa. The hooks are mounted

TONG HOOKS

on heavy forged two-wheel frames and are designed for removing the covers of furnaces.

With the new hook, one man only is needed to remove and replace the covers and there is no danger of the operator being injured when engaged in this work.

Correction

Renovating a Sulphide Mill.—In the article by Hugh K. Moore on "Chemical Engineering Aspects of Renovating a Sulphide Mill," published in our August 1 issue, page 120, the formula for B.t.u. per square foot per minute $= 2.66 \times 10^{11} (T_2^4 - T_1^4)$ should read as $2.66 \times 10^{-11} (T_2^4 - T_1^4)$.

Luminous Devices in the War

That luminous devices, made by radium luminous paint and other luminous compounds, should prove valuable in warfare is plainly evident. Horne's Luminous Company, Ltd., of North Cheam, Surrey, England, has been making some interesting devices for use at the front. The company is an old one in this field, being the successor to the original inventor of Balmain's luminous paint, Dr. W. H. Balmain.

A luminous night marching compass, of which 100,000 are being used by the Allied armies, is one of the devices made by the company, which is very busy with Government orders. A luminous linen collar beacon painted with Balmain's luminous paint is another interesting product. These linen tabs present a luminous surface of 10 sq. in., and are for attaching to the back of the tunic so that when the first line of men go over the top they are not mistaken for enemies in the dark by the second line of men who follow.

Spiked beacons are also made in the shape of large buttons (1¼ in. diameter), the Balmain's luminous painted top being covered with transparent celluloid, and surmounted on a small steel spike ⅜ in. long, which, by pushing, enters into any woodwork, and when affixed to the top of short stakes driven into the ground and placed 10 yd. apart, afford a guide to relief parties going and returning in the dark. One hundred of these 10 yd. apart serving 1000 yd., the stakes being placed in the day on fairly chosen level ground, they will act for months, taking up light each day and acting each night.

Luminous tape is another useful article for dark night operations.

This tape, if placed on the ground and secured by stakes, metal rods or stones, is prevented from being shifted by the wind.

The "tape layer" places the tape in position during the day, choosing a safe path across the country, and diverting from the straight path according to the condition of the ground. The path should be wide enough for men to march four abreast up one side of the tape and returning the other side, say, in all about 12 ft. wide. Where this is not possible the tape layer makes a break in the tape every few yards, and starts again continuously when the path is wider. Any obstacle in the way, such as a tree or post, could have a small length of tape tied round it.

But should a ditch come across the path he would lay short pieces of the tape at right angles on either side of the ditch. In case of the ditch being over 4 ft. deep, the man should have a Luminous Beacon with him and write on it the depth of the ditch, also the width, with a special pencil, and place it by the tape, when near the ditch. A No. 2 beacon would be the size for this.

Large letters can be easily composed out of this tape by nailing it up with zinc nails, such as "Fireman," "Doctor," etc., also for direction arrows.

These Luminous Beacons have been used for signalling silently by night. They are specially useful in trenches which are in close proximity to the enemy, saving the need of whispering the words of command, which causes a hushing sound, when complete silence is required for listening to the enemies' movements. A No. 2 size beacon will carry a message a distance of 20 yd., thus a No. 4 beacon would be seen over 10 yd. away. The signalling can be either done with the Morse code or by describing large capital letters of the alphabet the reverse way, and by the hand waving them in the air. The Royal Engineers were the first to use these devices.

The tape is also very useful for R.A.M.C. work—the tape-layer by daylight choosing fairly level ground to guide the stretcher bearers—thus saving their labor in the dark, and less jolting to the wounded. Moreover, lamps afford a mark for the enemy—whereas the tape can only be seen by those immediately over it—enabling work to be done silently in the dark, the darker the better.

Adiabatic Jackets for Calorimeters

Along with the increased use of the calorimeter for both commercial and scientific purposes there has been constantly growing a demand for improvements in the design of the jacket. This demand for improvements in the type of jacket has in view the elimination as far as possible of the exchange of heat between the calorimeter and the calorimeter jacket. This condition is desired principally in order to obtain increased accuracy in calorimetric work, and further it is desired that a calorimetric test can be made under these adiabatic conditions with the necessary time of test reduced.

These adiabatic jackets when operating properly eliminate the cooling correction. This is a desirable feature in scientific calorimetric work as it makes possible increased accuracy, and is of advantage in commercial work as it eliminates the time necessary in computation of the cooling correction and the time to take the thermometer readings, which furnish the necessary data for the cooling correction formulas.

A type of jacket which is designed to accomplish this adiabatic condition which is coming into considerable use is the vacuum walled jacket. This is the simplest type of jacket to operate, which practically eliminates radiations and is quite satisfactory for general calori-

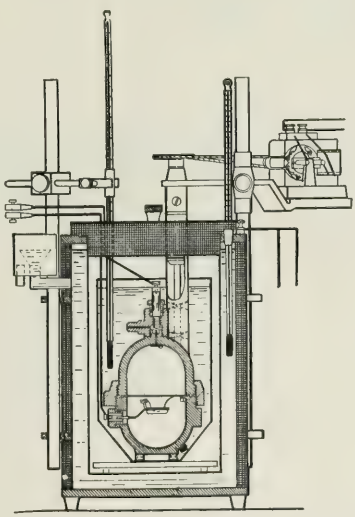


FIG. 1—THE EMERSON CALORIMETER EQUIPPED WITH DANIELS' ADIABATIC JACKET

metric work. If the temperature in the calorimeter with a vacuum walled jacket, however, is not fairly close to that of the room temperature, an appreciable exchange of heat does take place.

In addition to radiation when a test is made in a vacuum walled jacket at a temperature considerably above the room temperature, the condensation of vapor on the cover and upper walls of the jacket may introduce considerable cooling effect. A vacuum walled jacket when operated in proximity to room temperature gives satisfactory results, and except for the fragile nature of the jacket is very desirable for commercial work.

Several types of jackets have been used in which the temperature of the jacket is raised at a rate equal to the rate of rise in the calorimeter. Examples of this type are the jackets designed by Prof. T. W. Richards of Harvard and the jacket developed at the Bureau of Standards. Electric heaters are used in conjunction with stirring devices in these designs.

In the accompanying illustration is shown an Emerson calorimeter made by the Emerson Apparatus Company of Boston, Mass., equipped with a modification of an adiabatic jacket designed by Dr. Farrington Daniels of the Worcester Polytechnic Institute. In the Daniels jacket radiations are eliminated by carrying the temperature of the jacket along with the temperature of the calorimeter. The rise of temperature is obtained in the jacket without the use of electric heating coils. The jacket water itself is the heating unit, and by passing an electric current through the same its temperature is raised simultaneously with the calorimeter temperature. With the application of the current to the water jacket the temperature rises immediately and uniformly throughout the jacket.

In this manner the lag of the resistance wires of the heating coils is eliminated, as is also the stirring of the jacket water as the heat is not localized.

New Industrial Glasses

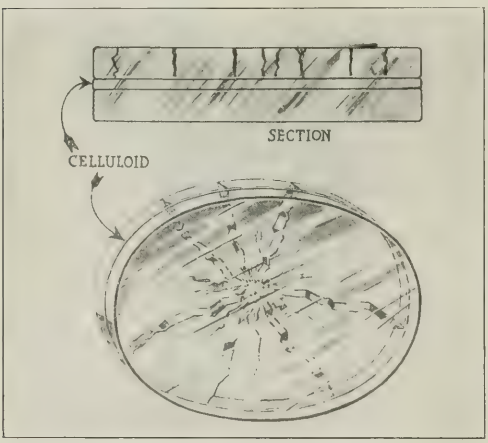
An interesting new safety glass has been developed by Strauss & Beugeleisen, 37 Warren Street, New York City, to be used in connection with industrial masks and goggles used for protective purposes to shield the eyes of the workmen from flying particles, dust, heat, light and injurious gases.

The feature of this new glass is the fact that while it can be cracked, it cannot be broken even with a hammer blow, while in cracking there is no flying of splinters to jeopardize the eyesight of the workman. When cracked the glass remains gas and water tight.

The construction of the glass, which is known as "resistal," is shown in the accompanying sketch. It comprises two layers of perfect optical glass, which may be either plain or curved, with a layer of celluloid interposed, the whole being welded into a solid mass.

The celluloid acts as a heat-insulating medium preventing "clouding up" due to moisture condensation.

Goggles fitted with these safety glasses have been adopted for the needs of the Aviation Corps, U. S. Army, while from the same quarter the makers have received orders for a large number of crystals for military gas mask purposes.



SHOWING THE CONSTRUCTION OF THE "RESISTAL" CRYSTAL

An Interesting Dump Car

In the accompanying illustration, Fig. 1, is shown an interesting dump car made by the Easton Car & Construction Company, Easton, Pa. The body of this dump car may be lifted off the frame, set down on another track and run in under a hopper for loading where head room is limited or space too narrow to permit the whole car to enter. After the car is loaded it may be hauled out, lifted by a crane onto the underframe again, and run out to the dump. The two sets of wheels and the crane lifting rings that make these operations possible are shown in the illustration.

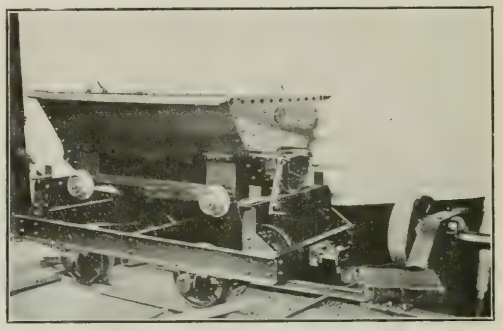


FIG. 1—DUMP CAR WITH REMOVABLE BODY

Old Cave Deposits of Nitrates in the South

The United States Geological Survey has investigated a cave in one of the Southern States which was worked by the Confederacy during the Civil War for potassium nitrate. This cave is said to contain at least 1,000,000 tons of nitrous earth, which, however, contains only 1 to 2 per cent of nitrate. The Survey states that it seems very doubtful whether such material can be profitably used as a source of nitrate salts. The minimum grade of caliche now worked in the Chilean fields contains 12 per cent of sodium nitrate, and though there has been much criticism of the crudeness of the methods employed there, the work is done by very cheap Indian labor, and it is doubtful whether leaner material could

be worked to advantage here, where the price of labor is so much higher. Several hundred thousand dollars has recently been expended in one of the Western States in testing the proposition to utilize low-grade nitrate. The results have been negative.

The nitrate caves in the South were worked during the Civil War by very crude methods. Generally the cave earth was shoveled into iron pots, where it was treated with water and heated over wood fires to leach out its soluble parts. The liquor was drawn from one pot into another and used for treating fresh material until it became a highly concentrated solution of nitrate salts. It was then drawn off and allowed to cool, whereupon the nitrate crystallized. The remaining liquor was then employed to leach fresh material and the crystals were separated and sacked for use.

Personal

Mr. **R. Atkinson,** formerly with the Maxwell Motor Co., Inc., has recently assumed the duties of metallurgist with the Domestic Engineering Co. of Dayton, Ohio.

Mr. **H. D. Batchelor** has been appointed head of the Cleveland laboratories of the National Carbon Co.

Dr. **C. F. Chandler,** emeritus professor of chemistry at Columbia University, was reported at the time of writing to be feeling considerdably better, following a period of illness.

Mr. **Welton J. Crook** has been ordered to the Officers' Training Camp at San Francisco. Mrs. Crook has taken over all his work and has accepted his position with the Pacific Coast Steel Co.

Mr. **C. A. Crowe,** formerly manager of the Grand Rapids office of the Asbestos Protected Metal Company of Pittsburgh, has been appointed to take charge of the Detroit office located in the Penobscot Building. Mr. **M. W. Taber,** formerly Detroit manager, has been appointed factory manager.

Dr. **Colin G. Fink,** for the past ten years in the research laboratory of the General Electric Company, has been appointed head of the new Chile Exploration Company laboratories located at 202nd Street and Tenth Avenue, New York City. The work in the new laboratories will be largely research along metallurgical and electrochemical lines. Dr. Fink is president of the American Electrochemical Society.

Mr. **J. E. Johnson, Jr.,** has gone to the Pacific Coast on a professional trip requiring six or seven weeks.

Mr. **Dorsey A. Lyon,** who has been in charge of the Bureau of Mines station at Seattle, has been appointed to the newly created post of superintendent of all stations, with headquarters in Washington. **Thomas Varley** will succeed Mr. Lyon at the Seattle station. Mr. Varley has been stationed at Moscow, Idaho. **Clarence A. Wright,** a metallurgical engineer who has been attached to the Salt Lake City station, has been transferred to Moscow, Idaho.

Mr. **Charles R. Oberfell,** for some years past chemist for England, Walton & Co., leather manufacturers, Third Street, Philadelphia, Pa., and at one time president of the American Leather Chemists' Association, has resigned to become connected with the John H. Heald Co., Lynchburg, Va., manufacturer of dyewood and allied specialties.

Mr. **Howard C. Parmelee** has resumed charge of the western office of Metallurgical and Chemical Engineering, with offices at 401 Boston Building, Denver, Col., succeeding Dr. Siegfried Fischer. Mr. Parmelee left the editorial staff of this paper a year ago to assume the presidency of the Colorado School of Mines, but was recently forced to retire from that position when he was not supported by the trustees of the institution in a matter of student discipline. Prior to leaving his editorial work, Mr. Parmelee was on the staff of this paper for six and a half years.

Prof. **Francis A. Thomson** has resigned from the faculty of the State College of Washington to accept the deanship of the School of Mines at the University of Idaho, Moscow, Idaho.

Obituary

Mr. **Joseph B. Jacoway,** who ever since the organization of the Pratt Engineering & Machine Company was manager of the Atlanta sales office, passed away Aug. 14 at Prescott, Ariz. He was born at Trenton, Ga., in 1883, and was well known to the fertilizer and acid trade.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Thursday, Sept. 5.—The features of the market have been the decline in lead and the sensational advance in silver to undreamed of levels. The other markets are practically unchanged.

Copper.—Strike conditions have improved slightly in the Arizona district, but the market has remained quiet and unchanged in price. Prompt Lake is quoted at 27.50 average and electrolytic at 25.50, which is a slight decline. Copper exports are now under control.

Tin.—Tin has advanced and declined fractionally during the last two weeks and spot Straits is slightly lower at 60⅞ cents. Spot Banca is quoted at 58.50 to 59.00 cents. Chinese futures are offered at 54.50 cents. Arrivals in August were about 2500 tons, with total deliveries of 2150 tons at Atlantic ports and 1155 tons at Pacific ports.

Lead.—The lead market has been very dull. The feature has been the reduction by the Trust from 11.00 to 10.50 on Aug. 29 and to 10.00 cents on Sept. 4. Independents have met this price with corresponding reductions. Little increase in business has followed the reductions, however.

Spelter.—There is nothing new in the spelter market, the price remaining at about 8.00 cents, New York basis. The situation continues unsatisfactory from the producers' standpoint.

OTHER METALS

Antimony, Chinese and Japanese, pound	$0.145
Aluminium, No. 1 Virgin, 98-99 per cent, pound	.46
Magnesium, metallic, pound	2.00–2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask	115.00
Silver, ounce	.95⅝
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

The Iron and Steel Market

The fore part of September has witnessed the same stagnation in the iron and steel market that characterized August, but progress continues to be made

along normal lines towards the price readjustment that is needed to enable business to proceed. The mills reduced their obligations on books and buyers received a corresponding amount of material, so that the existing engagements on the part of both buyers and sellers were much less at the end of the month than at the beginning. New tonnage entered during the month was chiefly of special character, partly Government orders and partly contracts from regular customers accepted at prices which long since disappeared as ordinary market quotations.

One feature of the progress that is being made is that there are heavy shipments of the highest priced tonnage sold in the past few months, during the period in which there was one price for regular forward deliveries, and much higher prices for early deliveries, made chiefly by mills that were not entering the far forward deliveries at all. Thus a condition is being approached at which the highest priced sales will have been executed, some lower priced tonnage remaining on books, so that a decline in the general market will not disturb conditions as much as would have been the case if it had occurred one month or two months ago.

The whole trade, producers and buyers alike, are anxious that a readjustment shall take place whereby prices may be put on an equitable basis, one that will afford a fair profit to producers and one that will enable consumers to continue in business. It has been recognized on all hands for many weeks that the steel market had worked itself into an impossible position, one from which there was no escape except by a reduction from the prices commonly quoted as representing the market, such prices at 9c. to 10c. for plates, 4.50c. for bars and shapes, 8c. to 9c. for black and blue annealed sheets, and so on. These prices have been obtained only for relatively early deliveries, and when such business has been worked off the price readjustment can occur with a minimum of disturbance.

READJUSTMENT MAKES PROGRESS

While there has been no general decline in the finished steel market there has been progress made just the same. In all readjustments after a period of continued price advances and heavy buying the market generally yields first on scrap, then on intermediate products and finally on the finished products. In this case scrap began to decline late in June and the decline continued during July, while in August the fluctuations practically balanced. The scrap market was waiting for finished steel to catch up. Pig iron softened slightly in July as to price, while the volume of business dropped to almost nothing, and no revival in buying has occurred. Unfinished steel began to decline early in August and declines have continued to date, latest offerings of billets being at $75, with a possibility that $70 could be done, while in June the market had become established at a minimum of $95.

While finished steel products have experienced no general decline as yet, plates, formerly the market leader, have dropped at least 1c. per pound, the market having formerly been established as firm at 9c. to 10c., while late in August there were many offerings at 8c. and some sales were effected at a shade less, 8c. being the maximum of the market at this writing, for tank quality, ordinary sizes. The general decline in finished steel appears first in plates by reason of several influences, the embargo on exports, the large amount of new capacity under construction, 125,000 tons per month of new capacity being expected within about six months, and the development that the Government's shipbuilding program is not consuming plates at the moment as rapidly as had been expected. The really large consumption will not occur for several months yet, when additional capacity will be available.

PIG IRON

That the general readjustment in prices now started rests upon a solid foundation and is not a temporary reaction is shown by pig iron. The rapid advances that occurred March to June inclusive were predicated upon scarcity, i.e., more steel-making capacity than blast furnace capacity to supply it. In July and August the condition was accentuated, pig-iron production declining on account of scarcity of coke, while there was more steel-making capacity available than could be utilized, yet the pig-iron market declined sensibly. According to the theory previously held it should have continued to advance.

In the valley market Bessemer pig iron had reached a point in June when the minimum was $56, valley furnaces, while $57.50 was paid for some prompt deliveries. Late in August there were purchases for immediate shipment at $50 and 52, and iron is now easily available at $50. Basic iron late in June sold at $53, valley, and there were reports of business at $54 being done, but in the closing days of August a sale of 5000 tons for nearby delivery was made at $48. Further declines would undoubtedly be recorded if there were enough buying to develop fresh market prices. Basic iron has declined in the East, but foundry iron in all districts is practically unchanged, quotations having simply become nominal. The furnaces are well sold up and know they could not secure much additional business even by large cuts.

FINISHED STEEL PRICES

At this writing the expectations entertained for weeks that the Government would name the prices it intends to pay for finished steel products are more definite, and an announcement may have been made before this report sees the light. Even this announcement will not set the market going, as there is little probability that such prices will set the standard for the general trade.

PRODUCTION STATISTICS

The Geological Survey presents final figures of coke production in 1916, closely conforming to the preliminary estimates made at the beginning of the year. The production of beehive coke was 35,464,224 short tons, performing the unexpected feat of breaking by 300,000 tons the previous record, made in 1907. By-product coke production amounted to 19,069,261 tons, against 14,072,895 tons in 1915, the previous record. This made the total for 1916 54,533,585 tons. The recently issued statistical report of the American Iron and Steel Institute gives the consumption of coke by (iron) blast furnaces at 44,431,905 tons, this being 81 per cent of

the total production, not including gas-house coke, which is not reported.

The production of iron ore in 1916 is reported by the Survey at 63,735,088 gross tons by the Lake Superior region and 11,432,584 tons by all other districts, making a total of 75,167,672 tons, against a previous record of 61,980,437 tons, made in 1913. The shipments in 1916 were 77,870,553 tons, representing a reduction in stocks at mines of 2,702,881 tons.

Chemical Market

COAL TAR PRODUCTS.—The situation covering products under this heading has been very quiet and uninteresting during the past two weeks and trading has been confined principally to orders for immediate or near-by needs. The trade is awaiting developments which may arise from purchases on the part of the government.

Benzol.—There has been comparatively little business passing in benzol during the interval. Dye manufacturers have been rather well covered by contracts and activity was confined to filling-in orders. Prices remain unchanged. So far no government business of importance has materialized.

Dinitrochlorbenzol.—This market has been established on a lower basis as a result of keen competition and increased production.

Aniline Oil and Salts.—Both of these markets have ruled easier. There has been little export demand for aniline oil, and while the production of salts continues light the demand has been limited.

Paranitraniline.—Contract prices have been lowered in the face of a restricted consuming inquiry and a large production. The situation is not entirely satisfactory from a manufacturer's viewpoint.

Monochlorbenzol.—The production appears to be increasing in a large way, and this coupled with a light export inquiry tends to create a weak market.

Toluol.—In contrast to the benzol situation, toluol has remained tight and there has been considerable business passing for prompt and near-by delivery. Contracts, however, have been limited owing to the uncertainty prevailing in regard to the possible purchases of the government.

Toluidines.—*Para* has been strong and advancing steadily. The *ortho*, however, has been neglected with supplies accumulating. *Ortho nitro toluol* has been rather easy. Manufacturers of *para nitro toluol* have experienced difficulties in their plants which so far have not been overcome.

Naphthalene.—The market has remained steady, but prospects do not appear particularly bright. Nitro and dinitro naphthalene prices remain unchanged with prices quiet.

Phenol.—In contrast to some months ago the market has remained strong and slightly higher. The outlook appears brighter than for some time.

Diphenylamine.—Prices have been higher owing to the very limited supplies available. Dinitrophenol prices have been lower owing to the heavier production and keen competition.

Xylol.—There has been much business transpiring. Both the commercial and the pure grades are lower.

Solvent Naphthas.—Contracts have been offered at lower prices and there seems to be sufficient material on hand to answer the requirements of the trade.

HEAVY CHEMICALS.—Considerable stimulus has been given to the general situation by the increasing strength in caustic soda and soda ash and other fundamental chemicals. The bichromates, both soda and potash, have increased steadily almost every day during the interval, and such items in light supply as yellow prussiate of potash and yellow prussiate of soda have also advanced. War orders have taken large quantities of caustic soda, heavy acids and ammoniates, and prices have tended upward for all these raw materials.

Caustic Soda.—While speculation has been partly instrumental in making for a widespread demand, the heavy consuming requirements together with the fact that most large producers are obligated for most of their spot and future production, have been the fundamental reasons for the tightening market.

Soda Ash.—This market has shown considerable strength both for near-by delivery and all future positions. Exports to the Orient especially are heavy, and considerable quantities are going from the West Coast; consuming demand here is also strong, and the makers are sold up. The market is in the hands of resellers.

Bleach.—Nothing of importance has occurred; a fairly steady tone is noted, and although the undertone is gradually increasing as the weather becomes cooler, prices for either domestic drums or export containers have not advanced much.

Arsenic.—No particular strength is shown in this market, and prices for future positions have shown a slight settling.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET SEPT. 6, 1917

Acetic anhydride	lb.	1 90	—	2 00
Acetone, drums	lb.	.35	—	.36
Acid, acetic, 28 per cent	lb.	.05½		.06
Acetic, 56 per cent	lb.	.10½	—	.11
Acetic, glacial, 99½ per cent, carboys	lb.	.36	—	.37
Boric, crystals	lb.	.13	—	.13½
Citric, crystals	lb.	.71	—	.73
Hydrochloric, commercial, 18 deg	lb.	.01⅞	—	.01¾
Hydrochloric, 20 deg	lb.	.01¾	—	.01⅞
Hydrochloric, C.P., conc., 22 deg	lb.	.01⅞	—	.02
Hydrofluoric, 30 per cent, in 1 barrels	lb.	.05	—	.05¼
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.04½	—	.05
Nitric, 36 deg	lb.	.06¾	—	.07
Nitric, 42 deg	lb.	.07¾	—	.08
Oxalic, crystals	lb.	.46	—	.47
Phosphoric, 85 per cent	lb.	.35	—	.39
Picric	lb.	.70	—	.75
Pyrogallic, resublimed	lb.	3 20	—	3 30
Sulphuric, 60 deg	ton	27 00	—	30 00
Sulphuric, 66 deg	ton	34 00	—	35 00
Sulphuric, oleum (Fuming), tank cars	ton	40 00	—	45 00
Tannic, U. S. P., bulk	lb.	1 35	—	1.40
Tartaric, crystals	lb.	.80	—	.81
Alcohol, grain, 188 proof	gal.	4 20	—	4.35
Alcohol, wood, 95 per cent	gal.	1 00	—	1 02
Alcohol, denatured, 180 proof	gal.	1 00	—	1.02
Alum, ammonia lump	lb.	.04½	—	.04½
Alum, chrome ammonium	lb.	.18½	—	.19
Alum, chrome potassium	lb.	.32	—	.34
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.08½	—	.09
Aluminum sulphate, technical	lb.	.02	—	.02½
Aluminum sulphate, iron free	lb.	.03¼	—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.12	—	.13
Ammonium carbonate	lb.	.11½	—	.13
Ammonium nitrate	lb.	.22	—	.24
Ammonium, sulphate domestic	lb.	.07½	—	.07⅝
Amyl acetate	gal.	4 50	—	4.60
Arsenic, white	lb.	.16	—	.16½
Arsenic, red	lb.	.60	—	.65
Barium carbonate, 99 per cent	ton	75 00	—	....
Barium carbonate 97-98 per cent	ton	65.00	—	....
Barium chloride	ton	85 00	—	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.11½	—	.12
Barium peroxide, basis 70 per cent	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine	lb.	.02	—	.02½
Borax, crystals, sacks	lb.	.08	—	.08½
Brimstone, crude	ton	60.00	—	65.00
Bromine, technical	lb.	.70	—	.80
Calcium, acetate, crude	lb.	.03	—	.03½
Calcium, carbide	lb.	.08	—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36 00	—	38.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.	.01½	—	.02
Carbon bisulphide	lb.	.07½	—	.08
Carbon tetrachloride, drums	lb.	.16½	—	.16¾

Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.09½	—	.09⅝
Chlorine, liquid	lb.	.15	—	.40
Cobalt oxide	lb.	1.40	—	1.50
Copperas	100 lb.	1.00	—	1.05
Copper carbonate	lb.	.42½	—	.45
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09¼	—	.09½
Cream of tartar, crystals	lb.	.48	—	.49
Epsom salt, bags	100 lb.	4.15	—	4.25
Formaldehyde, 40 per cent	lb.	.16	—	.16½
Glauber's salt	100 lb.	.80	—	.85
Glycerine, bulk, C. P	lb.	.64	—	.66
Iodine, resublimed	lb.	4.50	—	...
Iron oxide	lb.	.05	—	.15
Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.12¾	—	.13½
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.08	—	.09
Lithium carbonate	lb.	1.02	—	1.05
Manganese dioxide, U. S. P	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.16	—	.16½
Nickel salt, single	lb.	.11	—	.11½
Nickel salt, double	lb.	.08	—	.08½
Phosphorus, red	lb.	1.50	—	1.60
Phosphorus, yellow	lb.	2.20	—	2.25
Potassium bichromate	lb.	.41	—	.42
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.30	—	2.50
Potassium iodide	lb.	2.00	—	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330.00	—	340.00
Potassium nitrate	lb.	.29	—	.30
Potassium permanganate	lb.	4.00	—	4.25
Potassium prussiate, red	lb.	2.90	—	3.00
Potassium prussiate, yellow	lb.	1.15	—	1.25
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.10½	—	.11
Salammoniac, white gran	lb.	.16	—	.16½
Salsoda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide	oz.	...	—	...
Silver nitrate	oz.	.49⅞	—	.50⅞
Soda ash, 58 per cent. light, fat	100 lb.	4.00	—	4.25
Soda ash, 58 per cent, dense, fat	100 lb.	4.00	—	4.15
Sodium acetate	lb.	.10½	—	.11
Sodium benzoate	lb.	2.25	—	2.50
Sodium bicarbonate, domestic	100 lb.	2.25	—	2.50
Sodium bicarbonate, English	lb.	...	—	...
Sodium bichromate	lb.	.23	—	.24
Sodium bisulphite, powd	lb.	.04	—	.04½
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.40	—	4.45
Sodium nitrite	lb.	.45	—	.50
Sodium peroxide	lb.	.75	—	.80
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.32	—	.33
Sodium silicate, liquid -40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3.10
Sodium sulphide, 60 per cent, fused	100 lb.	4.50	—	4.55
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	3.95	—	4.00
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	.19	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	...
Zinc dust 350 mesh	lb.	.17	—	.19
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.05½	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	—	.52
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	1.75	—	1.80
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.31	—	.33
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carb. dic acid, crude, 95-97 per cent	lb.	1.00	—	1.05
Carb. dic acid, crude, 50 per cent	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.25	—	...

Intermediates, Etc.

Alpha naphthylamin	lb.	.70	—	.75
Aniline oil	lb.	.27	—	.28
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	...
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.85	—	1.90
Benzidine, sulphate	lb.	1.50	—	1.55
Benzoic acid	lb.	2.25	—	2.50
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	8.00	—	8.50
Beta naphthol, sal lmol	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	...
Dichlor benzol	lb.	.12	—	.18
Dinitrochlorbenzol	lb.	.44	—	.46
Dimethylaniline	lb.	.58	—	.60
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09	—	.09¼
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	...	—	...
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P	lb.	.42	—	.43
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.50	—	15.00
Salicylic acid	lb.	1.40	—	1.50
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	...
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	...
Corning, Ohio	bbl.	2.60	—	...
Somerset, Ky	bbl.	2.40	—	...
Wooster, Ohio	bbl.	2.38	—	...
Indiana	bbl.	1.98	—	...
Illinois	bbl.	2.12	—	...
Oklahoma and Kansas	bbl.	2.00	—	...
Caddo, La., light	bbl.	2.00	—	...
Corsicana, Tex., light	bbl.	2.00	—	...
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	...

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	...
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	...
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	...
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	...
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	...
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	...
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	...
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	...
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	...
Wood creosote, ref	gal.	.50½	—	...

Vegetable and Other Oils

China wood oil	lb.	19½	—	20
Cottonseed oil, crude	gal.	1.02	—	...
Linseed oil, raw, cars	gal.	1.24	—	...
Peanut oil, crude	gal.	1.17	—	1.20
Rosin oil, first run	gal.	.35	—	...
Rosin oil, fourth run	gal.	.66	—	...
Soya bean oil, Manchuria	lb.	.14	—	.14½
Turpentine, spirits	gal.	.42	—	...

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	28.00	—	32.00
Benzay, white, pure	lb.	.65	—	.68
Carnauba wax, flor	lb.	.53	—	...
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	...
Rosin, 280 lb	bbl.	6.00	—	...
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	.11½	—	...

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	...
Ferrochromium	lb.	.20	—	...
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	...
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	...
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Chrome ore, 46 per cent minimum, f.o.b. Cal., per unit	ton	.90		
Manganese ore, 48 per cent and over, per unit	ton	1.00		
Molybdenite, per lb. of MoS_2	lb.	2.10		
Tungsten, Scheelite, per unit of WO_3	ton	25.00		
Tungsten, Wolframite, per unit of WO_3	ton	24.00		
Uranium oxide, 96%	lb.	3.25	—	3.50
Vanadium Pentoxide, 99%	lb.			11.00

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The Advance Caulking Company, Chicago, Ill., has been incorporated in Delaware with a capital of $15,000 to manufacture caulking materials, etc. S. M. Paulsen, F. A. Bennett and W. L. Topper, Chicago, are the incorporators.

Aircraft Fireproofing Corporation, Wilmington, Del.; manufacture of chemicals, dyes, paints, etc.; capital, $600,000.

The Albamont Chemical Company, St. Louis, Mo., has filed articles of incorporation in Delaware with a capital of $100,000 to manufacture special chemical products. The incorporators are: William P. and A. White, and C. B. R. FitzWilliams, all of St. Louis.

American-Italian Commercial Corp., Dover, Del., $2,000,000.

The American Shell Company, New York, has been incorporated in Delaware with a capital of $2,000,000 to manufacture shells, castings, and kindred metal products. A. W. Britton, H. O. Coughlan, and Samuel B. Howard, 65 Cedar Street, New York, are the incorporators.

The Angola Tire & Rubber Company, Inc., Buffalo, N. Y., has filed articles of incorporation with a capital of $1,000,000 to manufacture rubber goods of various kinds. F. M. Wood, M. M. Levy and S. C. Kelly, all of Buffalo, are the incorporators.

Cable Chemicals Co., Cable, Ill., $5,000; W. C. Hibbert, A. E. Malone, Walter Rosenber, incorporators.

Carbon Products Co., Wilmington, Del., to contract, separate, treat and refine wax, tar, dyes, etc. J. G. Gray, M. B. F. Hawkins and H. M. Kennedy, incorporators.

Carlisle Cotton Oil Company, Carlisle, S. C., capital $20,000; incorporated. J. E. Lipscomb, president; M. C. Deaverll, vice-president, and W. H. Gist, secretary-treasurer.

Carolance Co. of America, Inc., New York City, $80,000. To manufacture dye stuffs, chemicals and drugs. Incorporators are M. Brusie, R. R. Robins and J. T. Crane.

Catchpole Foundry Corp., New York, $50,000. To build general foundry and machine shop. Walter Howard, A. G. Lewis and C. Willard Rice, incorporators.

Central Oil Burner Corp., Wilmington, Del., $160,000. To buy and sell a rotary burner.

Geo. W. Chapman & Co., Inc., New York City, $10,000. To manufacture paper, machie, and general construction business. G. W. Chapman, W. and W. P. Barker, incorporators.

The Chemical Corporation of New Jersey, Newark, N. J., has been incorporated with a capital of $25.000 to manufacture chemicals. S. Dowling, N. R. Crum and C. F. Crum, Newark, are the incorporators.

DeSoto Paint Mfg. Co., Memphis, Tenn., $100,000. Thos. F. Lillu, R. L. Defries and S. T. Carnes, incorporators.

The Forsythe Chemical Corp., Cleveland, O., $50,000. Incorporators, E. P. Dowling, J. L. Dowling, R. J. Moriarty, C. D. Ainger and P. B. Condit.

The Glen Rock Oil Company, New York, has been incorporated in Delaware with a capital of $20.000,000. The company will comprise a merger of the Glen Rock Petroleum Company, the Hall Oil Company, the Pilot Butte Oil Company and the Superior Oil Company. The last noted company maintains offices at 29 Lewis Street.

Goodrich-Lockhart Co., Orange, N. J., $250,000. To make and sell chemicals. Incorporators, E. J. McWhinney, W. J. Maloney and N. P. Coffin, Wilmington, Del.

Kootenay Silver Mines, Inc., Wilmington, Del. Capital, $1,000,000.

Marden, Orth & Hastings Corp., New York City, $1,950,000. To import and export oils, chemicals and dyestuffs. M. S. Orth, A. F. Burnham and E. N. Berkins incorporators.

The Marshall-Haley Mica Company, Philadelphia, Pa., has been incorporated with a capital of $10,000 to operate a plant for the production of mica and allied specialties. C. C. Bond, Ashbourn, heads the company.

Mogul Tires, Inc., Pearl River, N. Y., has been incorporated in Delaware with a capital of $2,500.000 to manufacture automobile tires and other rubber goods. Arthur R. Oakley, Pearl River; Richard A. Webster, New York, and W. E. Shields, Jr., Brooklyn, are the incorporators.

The Palmer Rubber Company, Poughkeepsie, N. Y., has filed articles of incorporation with a capital of $10,000 to manufacture automobile tires and other rubber goods. E. I. Dusenbury, J. F. MacDonald and F. D. Palmer, all of Poughkeepsie, are the incorporators.

Paper Products Machine Co., Boston, Mass., $50,000. P. T. Jackson, Jr., and Chas. H. Howard, incorporators.

Pennsylvania Explosives Co., New York City, $10,000. To manufacture blasting powder, explosives and chemicals. A. and S. T. Stern, incorporators.

Pensacola Fertilizer and Oil Co., New York City, $250,000. M. McGrath, L. Kallman and F. W. Miller, incorporators.

Perfenol Company, Elizabeth, N. J.; to manufacture synthetic products; $50,000. H. F. Ratigan, K. C. Fitz Simmons and R. T. Green, all of Paterson.

The Pneumatic Acetylene Generator Corp., New York City. J. G. Redmond, Chas. V. Kiernan and Otto Faelton, incorporators.

The Publishers Paper Co., Inc., New York City, $85,000. To manufacture paper and paper products. Incorporators are F. P. Sherwood, J. W. Burg, T. J. Walsh, incorporators.

Robinson Paint Company, Aurora, Ill., capital, $74,000. Incorporators, Harvey Musser, Harvey Gunsul, Olney Allen.

Harry V. Roeder, Inc., New York, has been incorporated with a nominal capital of $8,000 to manufacture chemicals and allied products. J. Edwards and O. R. and H. R. Roeder, 68 West Ninetieth Street, New York, are the incorporators.

The St. Louis Foundry & Manufacturing Company has been taken over by Orville Allen, J. I. McCormick and C. L. Graham of Alma, who will reorganize it with a capitalization of $50,000 and change its name to the Gratiot Foundry Co.

The Sheffield Iron Corporation, New York, has filed articles of incorporation with a capital of $777,500 to manufacture steel, iron and other metal products. J. R. Floyd, J. Gayley and H. K. Wood, 65 Cedar Street, New York City, are the incorporators.

Staier Chemical Company, Newark, N. J., to make and deal in chemicals of all kinds; $50,000. H. Staier and J. C. Staier, both of New York, and F. W. Miller, Newark.

The Standard Sulphur Corporation, Dover, Del., has filed articles of incorporation with a capital of $6,200,000 to operate a plant for the production of sulphur and kindred products. The incorporators are George G. Stiegler, W. F. O'Keefe and M. Gehrman, Wilmington.

The Sterizoil Co., Fostoria, N. Y., $250,000 W. R. Baker, G. D. Baker, M. F. Jacus, B Emmert, R. Kleinhen. To manufacture chemicals.

Stubner Chemical Works, Inc., Philadelphia, Pa., $100,000. To manufacture dyes and chemicals and alkalies. M. M. Clancy, Clement M. Egner, incorporators.

The Summit Mining & Milling Company, Wallace, Idaho, has filed articles of incorporation with a capital of $200,000. C. H. McLean, W. H. Robinson and J. H. McEvers, incorporators.

The Superior Copper Mine & Development Company, Vancouver, Wash., has been incorporated to develop copper mines in Skamania County. Company maintains head offices in the Couch Building, Portland, Ore.

The Synthetic Color & Chemical Company, Inc., Los Angeles, Cal., has been incorporated with a capital of $25,000 to manufacture chemicals and allied products. J. F. Long, Anton Dahl and M. A. Evans, Los Angeles, and B. A. Stiles and H. W. Schroeder, Glendale, Cal., are the incorporators.

United Ohio and Chemical Corporation; to deal in and with oils, greases, tars, chemicals, etc.; $2,000,000. F. A. Armstrong, C. M. Egner, W. S. Randall, Wilmington, Del.

The Vacuum Refrigeration Company, Philadelphia, Pa., has been incorporated under Delaware laws with a capital of $750.000, to manufacture refrigeration apparatus and kindred specialties. G. H. V. Martin, Philadelphia; S. C. Seymour and J. V. Pimm, Camden, N. J., are the incorporators.

The Watkins Tubeless Air-Cooled Auto Tire Company, Pittsburgh, Pa., has filed articles of incorporation under Delaware laws with a capital of $1,000,000 to manufacture automobile tires and kindred products. W. Burnside, Pittsburgh; T. C. Watkins, Ingram, Pa., and Morgan Howells, Orville, Ohio, are the incorporators.

The Watson Suspension Wheel & Rim Corporation, Dover, Del., has been incorporated with a capital of $1,000.000 to acquire and operate the plant of the Watson Suspension Wheel Company. M. H. Morris, A. M. Halloran and S. A. Williams, Wilmington, are the incorporators.

Western Alkali Refining Company, Wilmington, Del.; $2,000,000; to make alkali and chemicals.

Company Reports

The annual report of the AMERICAN AGRICULTURAL CHEMICAL COMPANY for the fiscal year ended June 30, issued recently, shows net profits of $5,546.355, an increase of $100,828 over the previous year. After the payment of dividends on the preferred amounting to $1,655,067, there was a balance of $3,891,288 available for the $18,430,900 common stock, an increase of $99,258 over the previous twelve months. This is equivalent to $21.11 a share on the common compared with $20.50 a year ago.

In his remarks to stockholders, President Peter B. Bradley says:

"With a rigid embargo placed on potash salts by the German Government early in the war, prices for potash rose over 100 per cent, nitrate of soda and sulphuric acid appreciated from 100 per cent to 300 per cent. while fuel, labor, machinery and other supplies rose to new levels. As a result, the whole industry became disorganized, necessitating a radical readjustment of prices to the higher costs of production, as well as many changes in the composition of mixed fertilizers, especially as to their content of potash, a normal supply of which was absolutely unobtainable at any price. Not only was the market for raw materials abnormal, but it was extremely unstable as well, making it difficult and even hazardous to name prices on manufactured products for future delivery.

"The past fiscal year has brought no relief to these exceptional conditions, but the enormous demand for food crops and cotton, brought about by the exigencies of war, has greatly stimulated the demand for fertilizers, so that there was no difficulty in selling all the manufactured fertilizers which were available last spring, though a still further rise in prices of raw materials, freights, insurance, etc., found the company's selling prices toward the end of the season out of line with the cost of production."

In the annual report of the VIRGINIA-CAROLINA CHEMICAL COMPANY recently issued, President S. T. Morgan remarks that the fertilizer consumption this year materially increased throughout the South, as a reflex of the poor cotton crop of the previous year, farmers learning thereby to fertilize much more liberally this year, with consequent increased business for the company and increased crops for themselves.

"The demand for fertilizers for the fall seeding of wheat is probably as large as, if not larger than, we have ever known it," the report says. "Every indication points to a consumption fully up to, if not more than equal to the supply. The prices will necessarily be high in comparison with previous years. The foreign exports by this company and its subsidiary companies, for some months past, have been largely cut off. Fortunately the domestic demand has been such as to enable us to take care of the business in a fairly satisfactory manner."

The business done during the year was the largest in the history of the company, amounting to $83,774,580, but much of this was due to increased prices, and the percentage of profit was relatively small, although the net earnings were the largest, also, in the history of the company

Construction and Operation

Alabama

SHEFFIELD.—That the Sheffield Rolling Mill plants will begin operation early in September was officially announced here recently by Armstead & Fulbright, lessees of the properties. The announcement is of great import to the people of Sheffield and coming just at this time with work already started at the iron furnaces of the Sheffield Coal & Iron Co., a feeling of genuine satisfaction and optimism prevails. Skilled labor of the highest type is employed in rolling mill work and the pay roll of the mill when it is in operation will amount to more than $30,000 monthly. Coincident with the rolling mill announcement to-day further interest is aroused locally by the presence of Warren L. Kluttz, recently appointed general manager of the Sheffield Coal & Iron Co., who arrived here yesterday to assume this official duty in control of the operation of the company's local plants, being accompanied by F. B. McKenzie of Tuscaloosa, who will become superintendent of furnaces, and J. M. Cosher of Birmingham, who it is stated will be connected with the company.

UNION SPRINGS.—The Southern Cotton Oil Company is now spending about $3,000 on the mill at this place in order to make the necessary changes for crushing peanuts and to modernize the mill for the crushing of cotton seed, according to I. M. Bryan, manager of the local plant. Mr. Bryan thinks the machinery will be in place and other changes made by Sept. 15, or by the time the crops begin to move.

California

LOS ANGELES.—Dwight Whiting, a young business man of Los Angeles and a member of one of California's oldest families, has pledged his personal fortune toward building an explosives plant. The new concern will be called the Whiting Powder Works. It will occupy a large tract of waste land and it will have an equipment sufficient to handle large Government orders.

SAN FRANCISCO.—Plans are being prepared for a $100,000 building project at Moss Landing, Monterey County for the recently incorporated California Sea Products Company, by Architect Henry Schultz on seven acres of land there that have been purchased by the company. Its purpose is to catch whales and utilize all of the leviathan's parts: the bone, much of the carcass for fertilizer, the skin for leather and choice parts of the flesh as whale steaks for consumption in the city and state.

SAN FRANCISCO.—Construction of one of the largest factory buildings on the Coast is nearing completion at Eighth and Brannan Streets, where the National Carbon Company is establishing its Facific Coast plant. The building was to be finished and occupied Sept. 1. Announcement was made recently that the company is preparing plans for a complete factory building adjoining the new structure, of which it will be an exact duplicate. The present structure is reported to have cost $500,000 and the proposed factory will represent an investment of a larger sum. The factory building has more than six acres of floor space. It is four stories high, with a high basement. The frontage on Brannan Street is 187 ft. and on Eighth Street 400 ft. Of reinforced concrete, the building represents the latest type of factory construction, having a complete concrete frame with monolithic floors and roof and practically all the exterior walls of steel frame windows and wire glass. The fronts are faced with terra cotta. Spur tracks connect the factory with the railroads. Five elevators will be used in the building, also two spiral chutes, a vacuum tube system, vacuum cleaning plant, intercommunicating telephones, modern heating and ventilating systems and similar equipment.

Connecticut

NAUGATUCK.—The Goodyear Metallic Rubber Shoe Company has commenced the construction of a new five-story plant, about 55 x 125 ft. Lockwood, Greene & Company, 60 Federal Street, Boston, Mass., are engineers.

STAMFORD.—The Stamford Rolling Mills has commenced the construction of a one-story addition to its plant, about 60 x 75 ft.

Delaware

WILMINGTON.—The Tabor-Davidson Company has filed notice of change in its company name to the Die Cast Fiber Company.

NEW CASTLE.—A portion of the plant of the Bethlenem Steel Company was destroyed by nre Aug. 14, with loss estimated at about $30,000. It is said that the loss will be immediately replaced.

Florida

JACKSONVILLE.—The Virginia-Carolina Chemical Co. has succeeded in securing from the City Commission a long time lease on certain property on the waterfront which will be used in establishing a permanent building for the manuiacture of fertilizer products. The corporation is one of the largest in the business and it is announced that when the plant is completed and put in full motion it will employ not less than 400 men. Jacksonville has developed considerably as a fertilizer center. Some of the largest plants in the South are already located here.

Idaho

MOSCOW.—A directory of mining properties in Idaho is being prepared by Prof. E. K. Soper and Prof. D. C. Livingston. The Legislature, at its last session, appropriated $4,000 for this purpose.

Illinois

CHICAGO.—John Miller & Sons, jobbers in leather and dealers in hides, have purchased the malthouse property on the Chicago River at Clybourn Place and the intersection of the St. Paul Railroad for $125,000, on which they will construct a tannery to cost probably $300,000. It is said that it will be one of the largest and best equipped plants in the country. This is a new tannery, the projectors not having been engaged in the tanning business before.

EAST ST. LOUIS.—The formal opening of the new $1,000,000 tannery of the International Shoe Company was held near Woodriver recently. Three hundred and fifty salesmen and officials of the company from all over the country came in seven special cars to view the plant. The plant will be put in operation within three weeks. Twenty-five men will be used at the start and at the end of three months 300 men will be working in the four-story brick building, which is 125 x 623 ft. One-sixth of the leather to be used by the International Shoe Company will be turned out at this plant.

EAST ST. LOUIS.—Location of a potash plant in the eastern part of the Washington Park industrial district is contemplated by the Alunite Company of America, with headquarters in Kansas City. The president is Thomas Twing, a prominent oil operator. The raw material will be transported from Colorado to East St. Louis.

Indiana

TERRE HAUTE. The Midland Electric Steel Company, recently incorporated, will put in operation early in October a 1200-kva., 3-ton holding capacity, two-phase, Booth-Hall electric steel furnace, capable of turning out 30 tons of steel per 24 hours, melting and refining cold scrap. The plant will be located at Terre Haute, Ind., in connection with the Highland Iron & Steel Company, an arrangement having been made for the latter company to roll the product, which will be forging billets 4 in. square and under. Mr. Joseph B. Moos, 116 South Michigan Avenue, Chicago, is president of the Midland Electric Steel Company. The directors are Mr. Moos, Mr. W. C. Ely, treasurer and general manager of the Highland Iron & Steel Company, and Mr. Moses E. Greenebaum, president of the Greenebaum Sons Bank & Trust Company, Chicago. Power for operating the furnace will be supplied by the Terre Haute, Indianapolis & Eastern Traction Company.

Maryland

BALTIMORE.—The United States Industrial Alcohol Company, New York, operating the Curtis Bay Chemical Company with plant at Stonehouse Cove, is planning for extensions and alterations in the works for the manufacture of potash. For the past twenty-four months the plant has been devoted to the production of high explosives, and necessary changes will be made to provide for the manufacture of the new product and also other by-products.

BALTIMORE.—The Baltimore Tube Company will build a new one-story rolling mill, about 145 x 540 ft. to cost $96,000. Contract for construction has been awarded.

ELKTON.—It is probable that the big paper mill of the Jessup & Moore Company, located at Providence, five miles north of Elkton, will be removed here. This big concern has already one of the largest pulp mills and bleach mills in the country, located in Elkton, on the banks of the Big Elk Creek, and has excellent railroad facilities.

Missouri

JOPLIN.—Another lead smelter is to be built in the Missouri-Kansas-Oklahoma district at a cost or approximately $150,000. Although the site has not finally been chosen it will be south of the Kansas-Oklahoma line, west of Quapaw, Okla. The Ontario Smelting Company, a Delaware corporation with a paid up capital of $250,000, is to build the plant. It will have a capacity of treating 500 tons of ore a week. Three different sites are under option by the company. C. V. Jones of Joplin is president and treasurer of the company.

Montana

COOKE CITY.—Dr. G. L. Tanzier of Seattle announces that the Cooke Smelter at Cooke City, completed last year, will be operated as soon as the company receives a permit from the Government to operate cars through the Yellowstone Park.

GREAT FALLS.—After an inspection of the local properties of the Anaconda Copper Mining Company, Chairman A. F. Spriggs of the Industrial Insurance Commission announced that safety appliances in both the B. & M. smelter and the big plants of the Montana Power Company are minimizing accidents to a large extent.

New Jersey

BOONTON.—The Knox Hat Company, Inc., has sold the factory which it formerly occupied at Boonton, N. J. The property consists of about five acres, with brick buildings, a private artesian well water supply and a railroad siding. The buyer, Stevenson & Co., a new firm, will use the factory for refining cocoanut oil into edible products.

CAMDEN.—The Wilckes, Martin, Wilckes Company, manufacturer of lampblack and allied specialties, is taking bids for the construction of a two-story addition to its plant, about 80 x 100 ft., on Pine Street.

HARRISON.—In order to provide for its steadily-growing business the Riverside Steel Casting Company will build a large extension to its foundry at the works on Passaic Avenue in the southern end of Kearny near Lincoln Highway.

JERSEY CITY.—The Seydell Manufacturing Company, 88 Forest Street, manufacturer of chemicals, is reported to be planning for the rebuilding of its plant recently destroyed by fire. Paul Seydell, president.

NEWARK.—The Butterworth-Judson Company, manufacturer of chemicals, has commenced the erection of several additions to its plant on Avenue R. The work will comprise a two-story factory, about 21 x 120 ft., to cost $20,000, and two condensing gas towers to cost $65,000.

NEWARK.—The Colt Machine & Engineering Company has awarded contracts for the construction of a new machine works on Colt Street, Irvington, to cost about $21,100. Charles Flocken, Newark, has the contract for erection.

NEWARK.—The Union Smelting & Refining Company has commenced the erection of a one-story brick addition to its plant, about 65 x 100 ft., on St. Charles Street, to cost about $20,000.

NEWARK.—The Hanson & Van Winkle Company, manufacturer of chemicals, will make extensions and improvements in its plant at Adams and Chestnut Streets.

NEWARK.—The F. W. Devoe & C. T. Raynolds Company, 223 New Jersey Railroad Avenue, manufacturer of paints and varnishes, has filed plans for the construction of a one-story brick addition, about 40 x 50 ft.

PATERSON.—The Commercial Chemical Corporation of New York, Newark and Hoboken has purchased a plot containing about twenty acres at the Boulevard and East Forty-third Street and plans will be prepared at once for the erection of a plant for the manufacture of perfumery and similar commodities.

PERTH AMBOY.—The American Smelting & Refining Company has commenced the erection of a new one-story tin furnace building. The structure will be about 40 x 110 ft.

PERTH AMBOY.—The American Encaustic & Tiling Company will build a one-story addition to its plant on State Street.

RAHWAY.—Merck & Company, Lincoln Avenue, manufacturers of chemicals, have awarded a contract for the construction of a one-story addition to their plant, about 40 x 56 ft.

HARRISON.—Reuther Brothers, Middlesex Street, operating a foundry for the production of gray iron castings, are planning for the early occupancy of their new plant now in course of construction. The new works are rapidly nearing completion, and represent an investment of about $40,000.

TRENTON.—The International Fibre Company, recently incorporated, has leased the plant of the American Rubber Manufacturing Company of New Jersey on Perrine Street, for the manufacture of artificial leather under a special process. It is reported that the American Rubber Company will be consolidated with the new organization. LeRoy W. Skelton and Peter E. Wurfflein head the company.

TRENTON.—The Delion Tire & Rubber Company has awarded contracts for the construction of a new two-story addition to its plant, about 65 x 290 ft., to cost $95,000.

New York

BROOKLYN.—The P. H. Gill Forge & Machine Company is planning for the immediate erection of a two-story addition to its works on Lorraine Street.

BUFFALO.—The Donner Steel Company will build a new one-story addition, about 30 x 35 ft., to its plant at 475 Abbott Road, to cost $10,000.

BUFFALO.—The American Radiator Company, it is reported, has acquired property at the corner of Delaware and Hertel Avenues, joining the site of its present Pierce plant, to be used for expansion.

BUFFALO.—Fire recently destroyed a portion of the main plant of the N. B. Fails Lubricating Company, Manitoba Street, with loss estimated at about $10,000. The company specializes in the manufacture of oils and greases. It is said that the plant will be immediately rebuilt.

CARTHAGE.—The E. R. Barker Company of Boston is installing one of their most modern acid plants and reclaiming systems in the plant of the Carthage Sulphite, Pulp & Paper Company. Floyd Hunkins, who was formerly superintendent of the Carthage Sulphite P. & P. Co., is the erecting engineer.

CASTLETON.—The Fort Orange Paper Company, manufacturer of cardboard, will build a new one-story addition to its plant on Oak Grove Road to cost about $18,000.

GOUVERNEUR.—J. H. McLear, chairman of the Trade and Manufacturing Committee on the Gouverneur Chamber of Commerce, who has been in communication with the New Jersey Smelting Company, which contemplates locating in this village in the near future, stated that in all probability the company would start building here in the near future as they find that the water supply which they require is available here at an economical figure. He stated that at the last meeting of the chamber that the company would require 30,000 hp. eventually and that the Oswegatchie Light & Power Company of this village were in a position to furnish that amount in the near future and that the lighting company has already given the Smelting company information to that effect and although the power is not at present available it can be produced in sufficient quantities to meet their demands as they increase their plant.

HASTINGS-ON-HUDSON.—The plant and business of the Pan Chemical Company, recently acquired by the duPont Chemical Works, 120 Broadway, New York, is being removed to Hopewell, Va. The company is planning for increased capacity at the new location.

NEW YORK.—The Government of Chile has decided to expend $8,500,000 in the improvement of Antofagasta, the principal port for the export of sodium nitrate. Chile's nitrate business has grown greatly because of the war's cutting off the German supply from other nations and also because the manufacture of munitions has increased the demand for saltpetre. One of the objects of Antofagasta improvements is to equip Chile to hold this greater nitrate business after the war is over. The Chilean Government has turned to the United States to have this work done and bids have been asked of American contractors for the construction of the waterfront improvements, as well as bids for taking up the loan the Government will make to finance the undertaking. The attention of American business men is also called to the fact that the improvement to the Port of Antofagasta is also important to the commerce of Bolivia, the port connecting with that country by the Chilean-Bolivian Railway.

SOLVAY.—The Semet-Solvay Company is negotiating with the Hamilton By-Product Coke Ovens, Ltd., Hamilton, Ontario, for the construction of a new by-product coke plant to cost about $2,000,000. The works will have a daily capacity of about 900 tons of coke and 7,000,000 cu. ft. of gas.

UNION.—The Union Chemical Company, Inc., a company with headquarters on North Chenango Street, Binghamton, has rented the buildings of the old carriage factory on Jennings Street, Union, and has installed vats and machinery. A force of men is hired and the factory ready for operation, but the raw material necessary has not arrived.

North Carolina

WILMINGTON.—The North State Pulp & Paper Company is planning for the construction of a new paper mill with daily capacity of about 100 tons. The company has recently increased its capital from $125,000 to $2,000,000 for the proposed extension, and a site for the mill has been acquired. W. H. Crocker is president.

Ohio

CANTON.—Negotiations have practically been completed for the sale of the Canton Sheet Steel Co., a $2,000,000 corporation, to Philadelphia interests.

CLEVELAND.—The Grasselli Chemical Co. has decided to enter the explosive industry. For the purpose a corporation known as The Grasselli Power Co. has been organized under the laws of Ohio, with a capital of $3,000,000. This company will take over the properties and business of the American High Explosives Co., and the Burton Powder Co., of New Castle, Pa., and the Cameron Powder Manufacturing Co., of Emporium, Pa. The Grasselli Powder Co. is a subsidiary of the Grasselli Chemical Co. The president of the new company will be Job Burton of Pittsburgh, now president of the Burton Powder Co. J. S. Burton will be the first vice-president and general manager of the new company. T. S. Grasselli will be second vice-president. E. R. Grasselli will be treasurer and R. R. Dixon will be secretary. Additional directors will be G. E. Fisher, second vice-president, and E. W. Furst, third vice-president of the Grasselli Chemical Co. At the offices of the Grasselli Chemical Co. it was stated that the manufacture of commercial explosives was so inter-related with manufacture of chemicals that this new department was a logical development for the Chemical company. The explosive industry requires for crude material sulphuric acid, nitric acid and other products which the Chemical company manufactures. The new company is not formed as a war order concern. It is an acquisition for permanent business, including among its products dynamite and the various powders used in blasting and other commercial channels.

CLEVELAND.—The Standard Steel Castings Co., incorporated under the laws of Ohio in 1912, with $125,000 capitalization, has increased its capital stock to $1,000,000. The company is engaged in the manufacture of steel castings, specializing in automobile work. The present plant is on West Seventy-third Street and the Big Four Railroad, but the growth of the business necessitates enlargement. Work will start soon on a plant on the East Side, to be devoted exclusively to manufacture of cast steel wheels for automobile trucks. The production of the miscellaneous castings will, however, continue in the present plant. The melting equipment in the new foundry will consist of two three-ton electric furnaces as well as converters. This new shop will have a capacity of 400 wheels a day, completely machined; this machine work is done in the company's machine shop. The officers of the company are: Julius F. James, president; Edwin F. Lee, vice-president and treasurer, and William R. McDonough, secretary and general manager. The directors in addition to the officers named above are: F. W. Moore, P. J. Morgan, M. C. Rosenfeld, R. M. Calfee, J. G. Fogg and B. C. Tucker.

CLEVELAND.—Erection of a large addition to the plant of the American Can Co. was announced recently following closing of a deal for nearly five acres of land fronting on Payne Avenue N. E. and the Pennsylvania railroad tracks. The deal for the land, which was one of the largest in the industrial line ever made in Cleveland, was closed through the real estate office of the J. Timendorfer Co. The land is estimated to be worth about $200,000 and the buildings for which it will form the site are to cost in the neighborhood of $2,000,000. Construction is to be started soon in order to take care at an early date of the growing output of the Cleveland branch of the can company.

YOUNGSTOWN.—The Linde Air Products Co. will open a plant in this city for the manufacture of oxygen within a short time. The new industry will be located at Jones and Brittain Streets and preparations are being made for its early operation.

Oregon

BEND.—A detailed examination of the nitrate deposits of central Oregon will be made by Hoyt S. Gale, of the U. S. Geological Survey. The matter is considered significant, as it means a reconsideration of resources in this section which had previously been refused by the Government.

EUGENE.—A new industry, the mining of chromite, has been built up in eastern Oregon as a result of the war, according to Dr. Warren D. Smith, head of the department of Geology of the University of Oregon. About 30 tons of chromite is shipped daily from Prairies City.

PORTLAND.—An addition to the Williamette Iron & Steel Company's plant on North Front Street will rise immediately, the contract having been let to McHolland Brothers. The building will be three stories and of brick. The dimensions are 56 x 62 ft.

VALE.—E. D. Gallagher, here, plans immediate construction of a large capacity reducing plant at Vale, to develop his company's nitrate properties.

Pennsylvania

BETHLEHEM.—The Bethlehem Steel Company has commenced the operation of a new open-hearth furnace with daily capacity of about 200 tons. The plant has been in course of construction during the past year, and will augment the tonnage at the works by about 60,000 tons a month.

BLOOMSBURG.—The American Car & Foundry Company is building a large addition to its plant to handle an order received from the Government for munitions. New machinery will be installed.

MARCUS HOOK.—The Benzol Products Company is reported to have acquired a large tract of property in the Claymont district to provide for the construction of a new chemical works. The General Chemical Company as well as the National Chemical & Aniline Company are affiliated with the Benzol company.

PHILADELPHIA.—The Main Belting Company, 1219 Carpenter Street, will soon call for bids for the erection of a new one-story addition to cost about $20,000. W. H. Castor, Stephen Girard Building, is architect.

PHILADELPHIA.—The Gorgas-Pierie Manufacturing Company, East Allen Street, manufacturer of oils, etc., has awarded a contract for the construction of a new five-story plant, 75 x 156 ft., at 144-164 East Allen Street, to cost $100,000. The Turner Concrete Steel Company, Philadelphia, contractor.

PHILADELPHIA.—George D. Wetherill & Company, manufacturer of paints, etc., will build a new four-story brick and concrete addition to its plant, about 45 x 80 ft.

PITTSBURGH.—The Universal By-Products Company, Ferguson Building, is reported to be planning for the construction of a plant at St. Petersburg, Fla., for the manufacture of leather specialties from shark skins. The machine installation will cost about $125,000, and the entire plant $375,000. Norman Lawrence is consulting engineer.

POTTSVILLE.—The Eastern Steel Company is said to be planning for the erection of extensions to its plant to increase the capacity about one-third. The proposed additions are estimated to cost about $500,000.

READING.—The Carpenter Steel Company is planning for the construction of several additions to its plant. Property has been acquired on other side of the Schuylkill River for the proposed works, and plans are being prepared for a reinforced-concrete bridge to connect the plants

West Virginia

PARKERSBURG.—The Beechwood Chemical Company is planning for the construction of a new three-story plant, about 54 x 110 ft.

PARKERSBURG.—The Cleveland Chain Manufacturing Company, Cleveland, Ohio, is said to have acquired a site for the construction of a local chain manufacturing plant to be used as a branch factory.

SOUTH CHARLESTON.—E. C. Klipstein & Sons Company, 644 Greenwich Street, New York, is making rapid progress in the construction of its new plant. The

works will specialize in the production of chlorine products, caustic soda, calcium chloride, and kindred specialties.

WHEELING.—The acid plant of the United Zinc Smelting Corporation's mammoth plant at Moundsville was put in operation the first week in August. The acid made is 60 deg. sulphuric. The following are the several parts of the plant in operation at the present time: Pottery, machine shop, kilns, ore crusher and acid plant. The roasted ore which is obtained at the Moundsville plant will be shipped to the corporation's plant at Clarksburg until the furnaces at this plant are completed. The two products made are zinc and sulphuric acid. When the furnaces are finished both these products will be made and the first unit will then be in full operation. The smelting plant with its connecting railways and storage houses covers nearly fifty acres of land and represents an expenditure of approximately $1,000,000.

Washington

BELLINGHAM.—What may prove to be a rich strike of tellurium in the Mount Baker region was uncovered at the Boundary Gold mine recently. Isaac D. Sperry, president of the Boundary-Golf Company owns the property.

CHEWELAH.—The manufacturing department of the Northwest Magnesite Company was expected to be placed in commission about Aug. 15. The investment of the company in improvements will be $260,000, including the erection of buildings to cover five acres, equipment and a tramway. Plant will be used in the refinement of magnesite and in the manufacture of magnesite specialties, including paper making. The production of magnesite has become a new industry for the State, and provided a new tonnage for the railroads. Company is shipping 10,000 tons a month.

COLVILLE.—A corporation being formed by Thomas W. Cole of Chicago and others, will build 14 miles of railroad in the magnesite district near Valley, Wash., in Stevens County. About $1,000,000 will be invested in the enterprise. Mr. Cole is connected with the American Minerals Production Company, one of the magnesite corporations operating in Stevens County. The new corporation will be known as the Spokane Valley & Northern Railway Company, with capital stock of $2,000,000.

IRONDALE.—The old iron smelter at this place will be in operation by the middle of September, according to announcement of the Pacific Coast Steel Company, which recently took over the holdings of the Western Steel Corporation, moving the rolling mills and open-hearth furnaces to its plant at Youngstown. The furnace has been overhauled and will be utilized in smelting about 20,000 tons of Chinese iron ore brought from the Orient by the Western Steel Corporation. Company plans to experiment with new process in reducing ores, which if successful, will insure continuous operation of the smelter. After the Chinese ore is exhausted ore from British Columbia and other points will be used. The product of the smelter will be sent to Youngstown, where it will be converted into steel at the company's plant.

SEATTLE.—The Puget Sound Art Glass Company has recently received an order for 3000 port lights for submarine chasers and other boats under construction at Bremerton, the Puget Sound Navy Yard. Company has recently established its plant in quarters on Westlake Avenue where it has 4000 sq. ft. floor space.

SEATTLE.—The Star Brass Works has enlarged its plant more than 50 per cent and increased its payroll 60 per cent, as the result of unusual demands for machined brass products. Company has recently moved to its new $8,000 plant at 1039 Railroad Avenue, and will add to its lines of manufacture several new types of brass machine products, making it the largest factory dealing exclusively in machine brass products in the Pacific Northwest.

SPOKANE.—Stockholders of the Canada Copper Corporation have received notice of a special meeting to consider details of the proposed 3000 ton daily capacity concentrator.

British Columbia

The value of metals produced in British Columbia in 1917 it is believed will be 25 per cent greater than that of 1916, which was $42,250,000. The increase would be greater, but for the interruption of smelting operations following the strike of coal miners. The strike affected the operation of three smelters, the Granby at Grand Forks, the British Columbia at Greenwood and the Consolidated at Trail—only the copper furnaces were affected at the latter point. All were restored to service recently, and operated to capacity.

The Granby Consolidated Mining, Smelting & Power Company, Grand Forks and Anyox, B. C., produced 3,147,886 lb. of copper in June. This compares with 3,159,284 lb. in May, the banner month. The production of June was made solely by the Anyox plant. Grand Forks plant resumed operations two or three weeks ago after an idleness of about three months, due to coal and coke shortage. Earnings of the Granby company in June were about $600,000, based on 20 cents a pound for the metal and cost of 11 cents for production. Company consumes about 6500 tons of ore, and similar amount of coke during a month. The most serious drawback to operations in British Columbia is the extreme uncertainty of the coke supply. The Crows Nest Pass coal fields are the only interior source of supply, and these mines appear to be almost constantly hampered by strikes, explosions or labor troubles. It is reported the Granby company, the largest single consumer of coke, proposes to go directly into the coal mining and coke-making industry to take care of the situation for its own needs. It has recently acquired 2000 acres of choice coal lands near Cassidy's Landing in the vicinity of Nanaimo, at a cost of $700,000, and proposes to expend $500,000 in improving them. At Anyox the company has a large steam auxiliary plant to supply power, when water supply is low. Its coal mines can thus supply immediate steam requirements when called upon.

TRAIL.—An average of 1600 tons of ore is daily being treated at the Trail smelter, and 2000 tons of high and low grade ore is passing through the Rossland smelter where for a number of years business has been at a low ebb. Labor in Trail is scarce, and wages high. Ore receipts at Trail during the last week in July totaled 9079 tons, the largest in many months. Settlement of the strike in Crows Nest and resumption of the coke supply are responsible for the increase. Total for the year to date is 200 237 tons. Important things are expected from the new oil-flotation process of smelting ores by which over 86 per cent of the mineral is extracted at Trail. It is stated that the new process has become so successful that practically all of the dumps are being repicked, and the low-grade ore, hitherto deemed of little value, is now being utilized with satisfactory results.

The Greenwood smelter of the Canada Copper Corporation will resume operations shortly. A coke supply for the operation of two furnaces has been arranged. One furnace was operated by the company for some months prior to the shut down caused by the Crows Nest strike.

POINT GREY.—Work is progressing on erection of the new Graham Products Company's plant at the foot of Oak Street, on the north arm of the Fraser River. Main building will be 50 x 150 ft. Eight evaporating kilns will be built.

COPPER MOUNTAIN.—The little test mill of the Canada Copper Company here is making a carload of concentrates weekly.

KAMLOOPS.—An option on a group of molybdenite claims has been taken by a group of European capitalists, and development work on a large scale will be undertaken. Claims are owned by Charles A. Mackay of Kamloops, Harold Chapman of Princeton, et al.

VICTORIA.—Plans are being worked out by city hall officials for the utilization of waste sawdust from the mills of the city, distilling it into cooking and illuminating gas.

KASLO.—The maganese deposits in the Kaslo district are being rapidly developed, and are proving of great value. The Bilcowe Alloys Company of Tacoma, Wash., has a contract to take 1000 tons of the product, and is urging the shippers to rush it through. Values are said to be good.

Manufacturers' Notes

McCARTHY DRILL & TOOL CORPORATION of Toledo, Ohio, with executive offices at 30 Church Street, New York City, has purchased the Toledo Drill & Tool Company, which has just moved into a new and enlarged fireproof two-story structure, where they have arranged to turn out large quantities of high-speed drills in addition to a full line of cutters and reamers. The McCarthy Drill & Tool Corporation has added new machinery and equipment so that they are in a position to produce vast quantities of high-speed twist drills with its new and modern machinery, and is now open to take on contracts and make prompt delivery for both millimeter and inch size high-speed twist drills.

THE KALBFLEISCH CORPORATION announces that it has a greatly increased output of permanganate of soda solution, and is now prepared to fill orders promptly for carload lots or less. A sample of the permanganate of soda will be shown at the coming National Exposition of Chemical Industries at the Grand Central Palace during the week of September 24.

GLASS CO. ELECTS OFFICERS.—At the annual meeting of stockholders and directors of the Johnston Glass Co., held at the general offices of the company, Hartford City, Ind., officers and directors were re-elected as follows: J. R. Johnston, Pittsburgh, president; George A. Schlosstein, South Charleston, W. Va., vice-president; George T. Fulton, Hartford City, secretary-treasurer. Directors: S. B. Fleming, New York City; John A. Jay, Kokomo, Ind.; Henry C. Mackney, Chicago; C. H. Hubbard, John C. Leonard and O. H. Hiatt, all of Hartford City.

Manufacturers' Catalogs

CARRIER AIR CONDITIONING COMPANY OF AMERICA, Buffalo, N. Y., has issued a booklet entitled "Keeping Cool in El Paso." It describes air fans and washers in use in this city. The company has also issued a folder entitled "Look Inside for Details," which is so made that it shows the actual construction of the carrier air washer.

UNIVERSAL VALVE CO., Burlington, Wis., has issued a booklet describing a swivel joint for use in steam, air, gas and ammonia lines, which requires no packing.

SPRAY ENGINEERING COMPANY, Boston, Mass., has issued Bulletin No. 311 describing the Spraco pneumatic painting equipment.

BUFFALO DENTAL MANUFACTURING COMPANY, Buffalo, N. Y., has issued a new catalog B-50, which is a most valuable reference work. The company is celebrating its fiftieth anniversary in the manufacture of high-class specialties for the chemical laboratory, including blast lamps, Bunsen burners, vacuum pumps, etc.

WALTER A. ZELNICKER SUPPLY CO., St. Louis, Mo., has issued Bulletin 221, listing offerings in rails, locomotives, cars, cranes, pipe, piling and tanks.

LINK-BELT CO., Chicago, Ill., has issued Book No. 361 entitled "Some Facts About Roller Chain Drives" and Book No. 326 describing Link-Belt "TT" class roller chains for tractors and trucks.

C. G. BUCHANAN CO., INC., 90 West Street, New York, has issued Bulletin No. 10 describing its all-steel type "C" Buchanan crusher.

Other New Publications

TALKS TO PLATERS. Given before the Bridgeport branch of the American Electroplaters' Society by F. C. Stanley. Published by the Bridgeport Branch. R. F. Clark, Box 671, Bridgeport, Conn., sectreas. Price 50 cents.

GAS CALORIMETER TABLES. Circular 65 of the Bureau of Standards, Washington, D. C. Price 5 cents.

MARKETS FOR CONSTRUCTION MATERIALS AND MACHINERY IN VENEZUELA. By W. W. Ewing. Special Agents Series No. 144 of Bureau of Foreign and Domestic Commerce, Washington, D. C. Price 10 cents.

LIMITS OF COMPLETE INFLAMMABILITY OF MIXTURES OF MINE GASES AND OF INDUSTRIAL GASES WITH AIR. By George A. Burrell and A. W. Gauger. Bureau of Mines Technical Paper 150.

STANDARD SAMPLES FOR THERMOMETRIC FIXED POINTS. Bureau of Standards Circular No. 66.

THE MINING INDUSTRY IN THE TERRITORY OF ALASKA DURING THE CALENDAR YEAR 1915. By S. S. Smith. Bureau of Mines Bulletin 142.

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A Consolidation of
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The Chemical Exposition

American chemical industry at high pressure is the impression gained by the visitor to the Third National Exposition of Chemical Industries. Excelling in magnitude and importance its two predecessors, the Exposition fitly typifies the wonderful growth and progress in industrial chemistry during the past year. Combining the exhibits with moving pictures of metallurgical and chemical industry and the technical sessions of chemical societies, the Exposition afforded educational possibilities unsurpassed in so small a time and area.

A number of features strike even the casual visitor and are worthy of brief note. First, the exhibits from the South made a deep impression regarding the present development and future possibilities of industrial chemistry in that part of our country. With raw materials, labor and power at hand in contiguous districts, the optimist of the South may be pardoned if he counts his region the greatest undeveloped asset of our country, and considers the present development to be trifling in comparison with future promise. Many of the southern exhibits were made by railroads and cities, indicating the strong forces that are behind this future development.

Another outstanding feature was the exhibition made by the related elements of the dyestuff industry. One was impressed with the great increase in by-product coking and the utilization of by-products for dye-making. Coal as a chemical microcosm was never displayed to better advantage than in the variety of exhibits shown at the Exposition.

From a metallurgical point of view the exhibits demonstrated remarkable progress in the manufacture of alloys for chemical purposes. The ability of the metallurgist to meet industrial demands, in the quality and quantity of alloys produced, as well as in the size of castings, is apparently without reasonable limit. The great quantity of commercial-size units of apparatus shown on the floor gave substantial evidence of what is being done. We look forward with pleasure to the fourth Exposition next year.

American Business Mobilized

Looking not only at problems pressing for immediate solution at Washington but also to the future relations of business and the Government, capital and labor, international business relations and such problems as government ownership of public utilities and the future of foreign trade, the recent War Convention of the Chamber of Commerce of the United States at Atlantic City was an important event. One gains the impression that the American business man of large affairs is viewing the future with a liberal attitude and breadth of

vision that considers the progress of human society rather than narrow selfish interest.

The old order changes rapidly, and the demand of the hour as well as of the future is an abandonment of narrow partisanship on the part of conflicting and competing interests. Changed times and conditions demand changed policies; patriotism as well as common sense call for harmonious action; race welfare is recognized as the paramount consideration of the hour. To bend business energies along these lines and subordinate many of the issues that formerly occupied attention, is the task which American business has set for itself.

The winning of the war is the first consideration and business realizes that this is more essential than making money. This is no time for capital to profiteer nor for labor to demand the closed shop; and if, out of a frank consideration of the war-time responsibilities of both parties we can emerge with clearer and broader vision and find common meeting ground, the war will have worked a change worth while.

Looking to the future of foreign trade and international relations of the United States, the convention emphasized the future necessity of shipping manufactured products instead of raw materials. This has been impressed on the metallurgical and chemical industries as a result of the war, and should receive thoughtful consideration for the future. With regard to minor as well as major, and rare as well as common, metals and products, the necessity of manufacture has become apparent. In this respect metallurgical and chemical ability is in advance of manufacture. We have the brains and ability awaiting financial and business arrangements. To-day metallurgy and chemistry are forward-looking industries, manned by able and competent men, and needing only financial co-operation and business organization for their firm establishment. With this co-operation we shall be able to meet the demand of business for industrial independence.

Scientists and Engineers in the National Defence

During the Washington meeting of the Electrochemical Society in the spring of 1916 the writer asked a friend to accept with him the invitation of the director of the Geophysical Laboratory to inspect their building and equipment. His friend declined saying something like "Why should I go over there? They have nothing but a lot of highbrows trying to find out how hot it is in the center of the earth." Meeting this body of real scientists and imbibing their enthusiasm for their work, however, was undoubtedly the most inspiring privilege of the occasion.

It is to be hoped that the ultra-practical man who didn't care how hot it was half way through the world could have attended the Boston meeting of the American Chemical Society and heard Dr. Day recount how this same group of men with their precise equipment and extraordinary learning were able to formulate and produce in the United States optical glass equal to any used in Europe, and in the amazingly short period of five months. Could he appreciate the immense value of this achievement, he would humbly thank Heaven for those same men who are giving their lives to the study of silicate minerals, ternary equilibria, and such other cryptic things.

The army officials of England and France felt much as my hard-headed friend toward the mobilization of the engineers into the trenches. Why should a chemist be kept rattling his smelly test tubes, or an engineer squinting through his transit when two-legged riflemen were needed in Flanders? Why, indeed? The answer was not altogether clear until sickening loss of human life had resulted from gas attack and from lack of powder and big guns. Then, when it was nearly too late, the engineer was put into his real job; the chemist started that flow of powder and gas which bids fair to overwhelm the enemy, the metallurgist produced that unending trail of guns and shells, big and little, while the humble surveyor mounted his "solar" on the top of a howitzer, peeked at a friendly sun or star, and sent the shells along their true courses.

While America is profiting by the experience of our Allies in many ways, the authorities seem to be blind to the special value of technically trained men. The President has indeed issued regulations regarding the exemption of medical students and hospital internes, and it is not entirely apparent why such additional provision should not be made for other technicians. Judging from the results of the activities of the National Engineering Societies, those in charge have not yet awakened to the urgency for action.

How they can continue in this attitude is a puzzle; consider for instance the list of exports forbidden to the enemy. These may be classed in the following general divisions: arms and ammunitions; transportation; bullion and money; chemicals; machinery; scientific and sanitary equipment; metals and ores; paper; rubber; fuel; foodstuffs; beverages; wood; clothing and fibers; earths; hides; organic products. The chemists or metallurgists are indispensable in no less than nine of the seventeen divisions either as king pins or foundation stones. Or examine the list of regulated exports to neutral countries and to the allies of the United States given on another page. Without the chemist or metallurgist no less than 121 out of the 206 items would be non-existent. Again, the most recent English list of absolute contraband contains 232 chemical or metallurgical products in a total of 339.

Surely if these materials are to be rigidly conserved as essential to the conduct of the war, is it not as necessary to place similar export limitations upon the brains which cunningly fashion them?

Assimilating Alien Labor

One of the most effective and important bits of work done by the Y. M. C. A. in mining camps and among aliens generally is instruction in speaking, reading and writing English. A knowledge of English on the part of foreign-born labor may be regarded as fundamental to the later acquisition of those ideas and ideals, cus-

toms and habits that we wish to inculcate in order to make a democratic American citizen. Speaking officially in his annual report for 1916, the president of the American Smelting & Refining Company says: "In the very serious and important matter of disseminating American ideals more thoroughly in the minds of our foreign-born labor, we are trying various methods of inducing the men to learn to read and speak English." This sentiment will probably find approval among high and subordinate officials of other companies, large or small, that have to deal largely with alien labor.

A common medium of expression seems essential to the mutual welfare of men who are are associated industrially, but who normally speak different tongues. It becomes a common point of contact and encourages closer relations. As an ideal means to this end we have had the suggestion of a universal language, and a number of engineers have from time to time interested themselves in Esperanto. Lacking the immediate attainment of such an ideal, however, the next best step is to familiarize the foreigner with the language of his adopted country. This is not merely to enable him to understand orders and perform his work intelligently, though that is essential; but there is the need of broadening his understanding and inculcating our ideals of government and citizenship. At the same time it is desirable that he be able to express his own ideas, hopes, aims and ambitions in terms intelligible to us. The lack of a common medium of expression is often the cause of misunderstandings of a minor nature which later may have grave consequences. Matters in dispute are not readily explained, and trouble is easily fomented by unscrupulous agitators speaking in a foreign tongue.

The problem in Colorado is being approached in a way that promises much for the future of industry in that State. The idea was suggested by Paul Lee Ellerbe, chief examiner of the U. S. Naturalization Bureau, Denver, as a result of the difficulties encountered by him in properly preparing aliens for naturalization. The aid of the extension department of the State University was enlisted, and classes have been organized in the industrial and mining centers of the State where foreigners are given instruction in English and citizenship. These classes are under the general direction of the extension division of the University, and are visited periodically by a field representative. The instruction is given by competent and interested citizens of the several localities, who devote several evenings a week to the work and find a wholesome response to their efforts. The idea is susceptible of elaboration and extension to include elementary instruction in other subjects. State Universities and Schools of Mines are the logical mediums for the work, while mining and industrial companies can and do co-operate by affording a place for meeting or contributing to the expense of instruction. The work is elementary, but fundamental in its importance as a factor in the assimilation of foreign-born labor into our body politic.

Silver and Gold

The price of silver has had a rapid rise of late, passing the dollar mark on Sept. 14, when the New York quotation was $1.005 per ounce. This fulfills the prediction of "dollar silver" made shortly after the beginning of the war, when it became apparent that the demand for gold would exceed the available supply and that silver would be needed as additional currency. To silver-producing districts such as Cobalt and Tonopah, this increase in price will come as a welcome offset to the extraordinary costs of mining and milling which have mounted rapidly in the past year. The change has not come as quickly as some predicted and hoped, but it has arrived inevitably in accordance with economic laws.

A shortage in the production of silver and the hoarding of a diminishing supply of gold are the fundamental reasons for the enhanced price of the former. Prior to 1893, when the Indian mints were closed to the coinage of rupees on private account, the import of silver into India was four times that of gold. India became known as the "sink hole" of silver, for once the metal was imported it never came out again. This condition then gradually changed as imports of gold into India increased as those of silver fell off. Absorption and hoarding proceeded until India became a "sink hole" of gold instead of silver. Hoarding also has occurred in other countries in recent years.

The enhanced value of silver has created an anomalous condition in the coinage of several governments, because the bullion value of silver coins has exceeded their value as circulating media of exchange. Thus the bullion value of the Honduras peso is now about 75 cents, whereas its gold value has long been quoted as 44 cents. The government is reported as meeting the situation by reminting the 250,000 pesos now in circulation into new coins of half the former silver content, thus creating 500,000 pesos of new currency. The new coins are to be accepted by the government in payment of custom duties and other obligations. Similar difficulties are encountered in Mexico, that peso being now worth about 75 cents gold. The Philippine peso also is above par, and regulations are in effect preventing its exportation as bullion. In the United States we are not yet confronted with a similar condition, for silver will have to sell at $1.29 per ounce before the price will equal our coinage value or parity with gold at a ratio of 16 to 1.

The general situation is well reflected in mining and metallurgical activity. Gold producers are confronted with the problem of meeting increased costs without being able to realize more for their product; and manufacturers of mining and milling machinery report a dearth of inquiries from new or prospective gold producers. Silver mines, on the other hand, are enjoying an approach to prosperity, with an increased price for their product with which to meet abnormally high costs of operation. In due time we may look for greater activity in silver mining if the price for the metal holds close to the dollar mark.

The Western Metallurgical Field

Settlement of Montana Copper Strikes

Sept. 17 was the date fixed for resumption of work in Montana following the labor strikes which affected the Anaconda Copper Mining Co. at its mines in Butte and reduction works at Anaconda and Great Falls. Based on a monthly production of about 29,000,000 lb. of copper it is estimated that the strike has delayed production to about 75,000,000 lb.

The strike was initiated through trouble occurring about two months ago between the electrical workers and the Montana Power Co., the men asking for $6 instead of $5 per 8-hour day, and for five and one-half days per week.

The power company was reluctant to grant all demands, and the men succeeded through union organization in arousing the mechanics of the Anaconda Copper Mining Co. to make certain demands on Mr. John Gillie, general manager. The exact wording was as follows:

"Unless the mining companies will bring pressure to bear to have the Montana Power Company grant their demands; and the mining companies grant the demands recently made by the miners, the members of No. 65 employed by the companies will be pulled off."

Mr. Gillie refused the demand and the electrical workers walked out.

On June 12 a general strike was called among the miners in Butte, which was not very effective until picketing was started. Both men and women among the Finns and Austrians participated in the picketing with the result that only about 50 per cent of the men reported for work. About this time the Anaconda company offered a new scale of wages, presented herewith, and work was resumed at the mines. An attempt was made to put a quietus on the I. W. W. element by men who took affairs into their own hands and lynched one of the disturbing leaders. Later, however, the I. W. W., encouraged by foolish remarks made by Miss Jeanette Rankin, Congresswoman from Montana, went to Anaconda and succeeded in persuading the smeltermen to quit work. The smelter was accordingly closed on Aug. 24, and the mines were again forced to close. The walk-outs on the part of individual unions were in spite of the fact that the Metal Trades Council, comprising twenty-one unions, had previously passed upon and accepted the wage-scale offered by the company.

Mr. W. H. Rogers, federal mediator, made an investigation of conditions and on Sept. 11 a general meeting was held at Anaconda at which the unions voted to reconsider the new wage scale. The result was the acceptance of the company's proposal and a general signing of cards requesting resumption of work. About 30 per cent of the normal crew reported for the day shift on Sept. 17, and it is expected that conditions will steadily improve.

ANACONDA COPPER MINING CO.
COMPARATIVE WAGE RATE OF PRINCIPAL OCCUPATIONS AT THE MINES AND REDUCTIONS WORKS,—BUTTE, ANACONDA AND GREAT FALLS

Sliding Scale Based on the Price of Electrolytic Copper

	Und. 15c	15c and Und. 17c	17c and Und. 19c	19c and Und. 21c	21c and Und. 23c	23c and Und. 25c	25c and Und. 27c	27c and Und. 29c	29c and Und. 31c
Old scale miners, all underground men engaged in mining	$3.50	$3.75	$4.00	$4.25	$4.25	$4.25	$4.50	$4.50	$4.75
New scale for same	**3.50**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**
Old scale for miners in shaft, station cutting and winzes	4.00	4.25	4.50	4.75	4.75	4.75	5.00	5 00	5 25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale blacksmiths, carpenters, machinists, electricians, boilermakers, painters	4.50	4.75	4.75	5.00	5.00	5 00	5.25	5.25	5.50
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, helpers for craftsmen	3.50	3.75	3.75	4.00	4.00	4.00	4.25	4.25	4.50
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, stationary engineers	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, hoisting engineers (first motion)	4.50	4.75	5.00	5.25	5.25	5.25	5.50	5.50	5.75
New scale for same	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**	**6.75**	**7.00**
Old scale, hoisting engineers (geared)	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, boiler cleaners	3.75	4.00	4.00	4.25	4.25	4.50	4.75	4.75	5.00
New scale for same	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**
Old scale, boiler cleaners' helpers	3.00	3.25	3.25	3.50	3.50	3.75	4.00	4.00	4.25
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, diamond drill runners	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale, firemen	3.50	3.75	4.00	4.00	4.25	4.25	4.50	4.50	4.75
New scale for same	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**
Old scale, laborers, special	3.50	3.50	3.50	3.50	3.75	3.75	4.00	4.00	4.25
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, laborers	3.00	3.25	3.25	3.50	3.50	3.75	4.00	4.00	4.25
New scale for same	**3.00**	**3.25**	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**
Old scale, drivers, locomotive, surface	3.50	3.75	3.75	4.00	4.25	4.25	4.50	4.50	4.75
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, pumpmen	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, shift bosses	5.00	5.25	5.50	5.50	5.75	5.75	6.00	6.00	6.25
New scale for same	**5.00**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**	**6.75**	**7.00**	**7.25**
Old scale, station tenders	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale, teamsters and stablemen	3.25	3.50	3.50	3.50	3.75	3.75	4.00	4.00	4.25
New scale for same	**3.25**	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**
Old scale, tool sharpeners	4.00	4.25	4.25	4.25	4.50	4.50	4.75	4.75	5.00
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**

(The foregoing schedule does not stop at 31 cents, but continues as per the foregoing increase at the rate of 25 cents for each 2 cents as high as the market price of copper. The column headed "25c. and Under 27c." represents the wage scale at the present time.)

Activity in the Missouri-Kansas-Oklahoma District

Visitors to the St. Louis meeting of the American Institute of Mining Engineers are to be treated to a trip through the wonderful zinc-lead districts of Missouri, Kansas and Oklahoma. Local committees are now busy preparing a souvenir book on the district, which is sure to reveal a condition not fully appreciated. As a forerunner to this, we note that the statistician of the Joplin *News-Herald* has compiled the total value of the metal output of the district since records first were kept. From 1859 to the present, including the first seven months of 1917, he estimates a total production value of lead and zinc amounting to $354,658,243. Extraordinary conditions this year account for $26,204,685 of the total.

Among the new mills and smelters planned in the district are a 600-ton mill for the U. S. Smelting Co., and one of 800 tons capacity for the Brown & Head Zinc Co. Both are announced as the most modern concentrators in the district, using ball mills for regrinding, and flotation for fine concentration in addition to the customary rougher and cleaner jigs and

tables. Announcement also is made of the construction of a new smelter, the first in the Oklahoma section of the tri-State field. This is being erected by the Ontario Smelting Co., near Quapaw, Okla., and is expected to be in operation within eight or ten weeks. It will have five furnaces with a capacity of 600 tons of ore per week. There are at present four other active lead smelters in the district: at Galena, Webb City, Joplin, and Granby.

Price Fixed for Copper

President Wilson approved on Sept. 20, an agreement between the War Industries Board and the copper producers, to furnish metal at a price of 23½ cents f.o.b., New York City. The official statement follows:

> After investigation by the Federal Trade Commission as to the cost of producing copper, the President has approved an agreement made by the War Industries Board with the copper producers, fixing a price of 23½ cents per pound, free on board, New York, subject to revision after four months. Three important conditions were imposed by the Board. First, that the producers would not reduce the wages now being paid; second, that the operators would sell to the Allies and to the public copper at the same price paid by the Government, and take the necessary measures, under the direction of the War Industries Board, for the distribution of the copper, to prevent it from falling into the hands of speculators, who would increase the price to the public, and third, that the operators pledge themselves to exert every effort necessary to keep up the production of copper to the maximum of the past, so long as the war lasts.
>
> The War Industries Board felt that the maintenance of the largest production should be assured and that a reduction in wages should be avoided. The stipulation that present wages shall not be reduced compels the maintenance of the highest wages ever paid in the industry, which without such stipulation would, with the reduction made in the price of copper, be reduced under the sliding scale so long in effect in the copper mines. Within this year copper has sold as high as 36 cents per pound, and the market price would now be higher than it is had it not been well known for some weeks that the Government would fix the price.
>
> The principal copper producers throughout the country have evinced an admirable spirit and for weeks have promptly supplied every request of the Government for copper without awaiting decision as to price and agreeing to accept the price which the board should ultimately fix. The proper departments of the Government will be asked to take over the mines and plants of any producers who fail to conform to the arrangement and price, if any such there should be.

Steel Corporation Increases Wages

The United States Steel Corporation announced that the wages of its employees would be increased 10 per cent on Oct. 1. Approximately 275,000 men will be affected by this, the second wage advance of the year, and the fifth since Feb. 1 of last year, each being 10 per cent. The successive increases will make the daily or monthly pay of the employees 60 per cent higher than it was at the end of 1915.

It is estimated that the various subsidiary companies employ about 200,000 day laborers who are now getting an average of $3 a day for ten hours' work. The increase on Oct. 1 will amount to 30 cents a day for this class of employees and will cause an aggregate increase of the corporation's annual pay-roll of approximately $18,000,000.

The Steel Corporation let it be known on the occasion of the wage increases last year that the rising cost of living and the desire of the employers to let the workers share in the abnormal profits of the period were the moving factors. Voluntary expansion of the payroll has had influence in keeping the men satisfied, as the corporation has had no serious labor difficulties since the war began.

Company Reports

In the accompanying table we present comparative figures on important items taken from the 1916 annual reports of several large copper companies, all of which are engaged in the mining and concentrating of low-grade copper sulphide ores. Other interesting facts which cannot be tabulated are given below.

Chino Copper Company's mill at Hurley, N. M., was built originally for a capacity of 5000 tons per day, but subsequent improvements in operating methods finally raised the capacity to a daily average of 8455 tons in 1916. In that year further improvements were inaugurated, and the construction of two new sections was begun. The full effect of this work probably will not be felt until the latter part of 1917. One of the sections and part of the other will supplement the original grinding equipment by an extensive installation of fine-grinding machinery and some concentrating machinery for the sulphide ores. A part of the second section will be devoted to the treatment of partly oxidized ore as long as such material is produced, after which it will be converted to the treatment of normal sulphide ore. It is estimated that the seven-section plant will have a daily capacity of 12,500 tons. An experimental plant of 100 tons daily capacity was constructed for investigation of the treatment of all classes of ore, and has afforded valuable information. A plant of 1000 tons daily capacity also has been built for the re-treatment of accumulated tailings, and when it has been run for a sufficient time to determine the best method of treatment it is the intention to increase the capacity to 5000 tons daily.

Ray Consolidated Copper Co. conducted during 1916 a campaign for greater capacity and improved metallurgical results. The effect was not apparent until the third quarter of the year, when both tonnage and extractions were the highest ever attained for a quarterly period. Further improvements are under way, and when completed will permit of better treatment of a larger tonnage than ever before. The original capacity of the mill was 6000 tons daily, but this will be raised to approximately twice that tonnage, and with better extraction than has been accomplished at any previous time.

	Utah	Chino	Ray	Inspiration	Miami	Braden
Ore reserves, tons	369,854,558	94,490,936	93,373,226	91,789,120	50,400,000[2]	219,680,000
Per cent copper	1.41	1.655	2.03	.....	.....	2.19
Ore milled, tons	10,994,000	3,094,400	3,332,340	5,316,350	1,842,017	1,362,629
Daily average, tons	30,038	8,455	9,105	14,850	5,074	3,723
Per cent copper	1.435	1.83	1.607	1.548	2.07	2.13
Concentrates, tons	.....	254,852	188,778	.....	66,289	117,984
Per cent copper	18.71	14.82	19.91	.....	42.49	.....
Copper produced, pounds	196,752,631	75,551,376	75,182,915	119,431,389	56,335,103	.....
Extraction, per cent	62.34	66.59	70.20	74.86[1]	73.88	75.07
Milling cost per ton, cents	37.82	64.00	55.35	.....	58.91	.....
Cost of copper, cents per pound	6.95	8.70	10.13	8.67	9.52	8.03

[1]Extraction of sulphide copper was 90.95 per cent; of oxide, 16.6 per cent.
[2]16,400,000 tons at 2.4 per cent; 28,000,000 tons at 1.06 per cent; 6,000,000 tons at 2 per cent.

Inspiration Copper Co. brought the eighteenth section of its mill into operation on Feb. 21, 1916. Flotation plays a large part in the metallurgical scheme at this mill, and as a consequence the recovery on sulphide copper ore was 90.95 per cent. The recovery on oxidized ore was but 16.6 per cent. The flotation concentrate carried 37.5 per cent copper and the table concentrate 11.23 per cent. Steel ball consumption per ton of ore treated was 1.76 lb. Flotation oil consumption per ton of ore milled was 1.286 lb., of which 1.2 lb. was coal tar and the balance other oils. Two additional sections of the mill were started in 1916, making 20 in all. The completed mill will have a capacity of about 18,000 tons per day, while the mine is in condition to supply 20,000 tons daily. Active experimental work was undertaken during the year on the treatment of oxide ores, of which the company has about 20,000,000 tons in reserve. A leaching scheme is now being tried out in a small plant.

Miami Copper Co. expects ultimately to bring its concentrating plant to a daily capacity of 6000 tons through changes in the mill, as determined from the operation of a 100-ton test mill. Changes will consist mainly in the increase of grinding capacity and provision of treatment facilities to handle the increased tonnage of more finely ground ore. Intermediate crushing rolls will be replaced by Hardinge conical mills, and the present fine-grinding mills by similar machines of greater capacity operating in closed circuit. All changes are expected to be completed by the close of 1917. Encouraging results have been obtained from experiments on treatment of oxidized copper ore, and a process is being tested on a large scale.

Braden Copper Co. states in its annual report for 1916 that the mill recovery has been greatly improved by the new air cells, and that the mill capacity is now about 5000 tons daily. In view of the large ore reserves, the management has considered the ultimate enlargement of the plant to 10,000 tons daily. Owing to a failure of the tailings dam in June, a new tailings dump has been secured about eight miles by flume line from the mill. This site has capacity for 200,000,000 tons, and will permit of safer and cheaper tailings disposal. The proposed enlargement of the concentrating mill made it necessary to change the location of the proposed new smelting plant from Sewell to Caletones, seven miles distant. Concentrates will be transported from mill to smelter by aerial tramway. A new department has been organized for welfare work among the company's employees. A sum of $2,000,000 has been set aside for the organization and operation of this department, which will look after housing, sanitation, amusements, education, and safety of a population of about 10,000 people.

Steel Prices and Priority Rules

A formal announcement was issued Sept. 24, regarding the price of steel and allied products, as follows:

> The President has approved an agreement between the War Industries Board and the steel men, fixing the following prices, which become effective immediately, and are subject to revision Jan. 1, 1918:
>
> Iron ore, lower lake ports.....$5.05 per gross ton
> Connellsville coke .....$6.00 per net ton
> Pig iron .....$33.00 per gross ton
> Steel bars, Pittsburgh or Chicago .....$2.90 per hundredweight
> Shapes, Pittsburgh or Chicago.$3.00 per hundredweight
> Plates, Pittsburgh or Chicago.$3.25 per hundredweight
>
> It was stipulated, first, that there should be no reduction in the present rate of wages; second, that the prices above named should be made to the public and to the Allies, as well as to the Government, and, third, that the steel men pledge themselves to exert every effort necessary to keep up the production to the maximum of the past, so long as the war lasts.
>
> Measures will be taken by the War Industries Board for placing orders and supervising the output of the steel mills in such manner as to facilitate and expedite the requirements of the Government and its allies for war purposes, and to supply the needs of the public according to their public importance and in the best interest of all, as far as practicable.
>
> A spirit of co-operation was manifested by the steel men, and no doubt is entertained that every effort will be made to bring the production as nearly as possible up to the extraordinary demands resulting from the war.

It is understood that the prices now quoted will not affect existing contracts, at least where war work is involved, and that pending the time when these contracts run out—they are usually for about seven months in the steel industry—the average price paid for steel will be at least $75 or $80, perhaps somewhat more.

The United States Shipping Board, through its Emergency Fleet Corporation, has been paying $50 a ton on account for steel plates, pending the announcement of the Government price.

The Navy Department has been paying, under agreement with the steel industry, $58 a ton for plates. This price will be maintained for the contracts already entered into, and the navy will then join the other Governmental agencies, the Allies, and the public in paying $65 for its plates.

Coincident with the President's announcement, Judge Robert S. Lovett, chairman of the Priority Board, issued a statement placing the distribution of iron and steel under absolute control by license. Preference will be given to the War and Navy Departments and the Emergency Fleet Corporation of the United States Shipping Board. Next will come the supply for the needs of the Allies. Private interests not engaged in war work must wait until the last before obtaining supplies.

The announcement of the board's plans through the Committee on Public Information reads in part:

> Under these regulations all orders and work are divided into three classes:
>
> Class A comprises war work—that is to say, orders and work urgently necessary in carrying on the war, such as arms, ammunition, ships, etc., and the materials required in their manufacture.
>
> Class B comprises orders and work which, while not primarily designed for the prosecution of the war, yet are of public interest and essential to the national welfare, or otherwise of exceptional importance.
>
> Class C comprises all orders and work not embraced in Class A or Class B.
>
> All orders henceforth will be classed as Class C, unless covered by certificates of the Priorities Committee. No certificates will be issued for Class C orders.
>
> Orders and work in Class A will take precedence over those in Class B, and both these classes will be given priority over Class C, irrespective of the date the orders were received. Class A and Class B will, in turn, be separated into subdivisions to be designated as Class A1, A2, A3, A4, etc., and Class B1, B2, B3, B4, etc., each composed of orders within the class which are regarded respectively as of greater moment and to be given precedence in accordance with the serial number. All materials required in the manufacture of an article or in the prosecution of any work will be entitled to take the class of such article or work unless otherwise specified.

The Regulation of Exports

The Espionage Act, approved June 15, 1917, provides for the regulation of exports in order that the United States may better conserve its resources and more efficiently use its exports and exporting facilities to aid in the prosecution of the war.

PURPOSE OF LAW

The purpose of the law and what is expected to be accomplished through its enforcement are probably best explained in the statement of the President, issued June 26, 1917:

> "It is important that the country should understand just what is intended in the control of exports which is about to be undertaken, and since the power is vested by the Congress in the President, I can speak with authority concerning it. The Exports Council will be merely advisory to the President.
>
> "There will, of course, be no prohibition of exports. The normal course of trade will be interfered with as little as possible, and, so far as possible, only its abnormal course directed. The whole object will be to direct exports in such a way that they will go first and by preference where they are most needed and most immediately needed, and temporarily to withhold them, if necessary, where they can best be spared.
>
> "Our primary duty in the matter of food-stuffs and like necessities is to see to it that the people associated with us in the war get as generous a proportion as possible of our surplus; but it will also be our wish and purpose to supply the neutral nations whose peoples depend upon us for such supplies as nearly in proportion to their need as the amount to be divided permits.
>
> "There will be little check put upon the volume of exports and the prices obtained for them will not be affected by this regulation.
>
> "This policy will be carried out, not by prohibitive regulations, therefore, but by a system of licensing exports which will be as simply organized and administered as possible, so as to constitute no impediment to the normal flow of commerce. In brief, the free play of trade will not be arbitrarily interfered with; it will only be intelligently and systematically directed in the light of full information with regard to needs and market conditions throughout the world and the necessities of our people at home and our armies and the armies of our associates abroad."

By proclamation of the President, of August 27, 1917, effective August 30, 1917, restrictions are listed in two distinct classes. The first includes the shipment of practically all articles of commerce, the export of which is prohibited to the enemy and its allies, and to the neutral countries of Europe; the second class includes certain commodities, the shipment of which is prohibited to countries other than those named under the first class. This classification of exports enables this country to maintain a close supervision and control of exports, with respect to those neutrals within the sphere of hostilities.

EXPORTS TO THE ENEMY AND TO THE NEUTRAL COUNTRIES OF EUROPE

The President's proclamation gives the following list of articles, the export of which to the enemy and to the allies of enemy countries and to the neutral countries of Europe will not be permitted without export licenses:

> Arms, guns, ammunition and explosives of all kinds, machines for their manufacture or repair, component parts thereof, materials or ingredients used in their manufacture, and all articles necessary or convenient for their use.
>
> Contrivances for or means of transportation on land or in the water or air, machines used in their manufacture or repair, component parts thereof, materials or ingredients used in their manufacture and all instruments, articles and animals necessary or convenient for their use; all means of communication, tools, implements, instruments, equipment, maps, pictures, papers and other articles, machines and documents necessary or convenient for carrying on hostile operations.
>
> Coin, bullion, currency, evidences of debt, and metal, materials, dies, plates, machinery and other articles necessary or convenient for their manufacture.
>
> Fuel, food, foodstuffs, feed, forage and clothing, and all articles and materials used in their manufacture.
>
> Chemicals, drugs, dyestuffs, and tanning materials.
>
> Cotton, wool, silk, flax, hemp, jute, sisal and other fibres and manufactures thereof.
>
> Earths, clay, glass, sand and their products.
>
> Hides, skins and manufactures thereof.
>
> Non-edible animal and vegetable products.
>
> Machinery, tools and apparatus.
>
> Medical, surgical, laboratory and sanitary supplies and equipment.
>
> Metals, minerals, mineral oils, ores, and all derivatives and manufactures thereof.
>
> Paper, pulp, books, and printed matter.
>
> Rubber, gums, rosins, tars, and waxes, their products, derivatives and substitutes and all articles containing them.
>
> Wood and wood manufactures.
>
> Coffee, cocoa, tea, and spices.
>
> Wines, spirits, mineral waters and beverages.

EXPORTS TO NEUTRAL COUNTRIES AND TO THE ALLIES OF THE UNITED STATES

Regulation of exports to neutral countries, other than those of Europe, and to countries associated in war with the United States, is also effected. These exports which are prohibited except by license are as follows:

- Coal
- Coke
- Fuel oils:
  - Lubricating oil
  - Hand lantern oil
  - Naptha
  - Benzine
  - Red oil
  - Kerosene and gasoline including burners
- Food grains, flour and meal therefrom:
  - Corn flour
  - Barley
  - Rice flour
  - Rice
  - Oatmeal and rolled oats
  - Fodder and feeds
  - Oil-cake and oil-cake meal
  - Malt
  - Peanuts
- Meats and fats
  - Poultry
  - Cottonseed oil
  - Corn oil
  - Copra
  - Cocoanuts, dessicated
  - Butter
- Fish, dried, canned or fresh
- Grease, inedible or edible, of animal or vegetable origin
- Linseed oil
- Lard
- Tinned milk
- Peanut oil and butter
- Rapeseed oil
- Tallow
- Tallow candles
- Stearic acid
- Sugar
- Glucose
- Syrup
- Molasses
- Pig iron
- Ferrosilicon
- Spiegeleisen
- Steel ingots
- Steel billets
- Steel sheet bars
- Steel blooms
- Steel slabs
- Iron and steel plates, including ship boiler tank and all other iron and steel plate one-eighth of an inch thick and heavier, and wider than six inches
- Iron and steel structural shapes
  - Channels
  - Beams
  - Angles
  - Tees, and Zees, all sizes
- Fabricated structural iron and steel, including beams, channels, angles, tees, zees, and plates, fabricated and shipped knocked down
- Scrap iron and scrap steel
- Ferro-manganese
- Guano
- Humus
- Hardwood ashes
- Soot
- Anhydrous ammonia
- Aeronautical machines and instruments, parts and accessories thereof
- Arms, ammunition, and explosives:
  - Nitrate of potash
  - Rosin
  - Sulphur
  - Saltpetre
  - Turpentine
  - Potash and its salts
  - Mercury and its salts
  - Glycerine
  - Carbolic acid and its derivatives
  - Phenol
  - Nitric acid and its salts
  - Ether
  - Alcohol
  - Sulphuric acid and its salts
  - Acetone
  - Cyanides
  - Benzol and its derivatives
  - Toluol and its derivatives
- Carrier and other pigeons
- Anti-aircraft:
  - Instruments
  - Apparatus
  - Accessories
- Radio and wireless:
  - Apparatus
  - Accessories
- Optical glass, instruments and reflectors
- Cotton and cotton linters
- Wool, wool rags, wool and khaki clippings and wool products
- Flax, sisal, jute, hemp and manufactures thereof
- Hides, skins and leather:
  - Leather belting
  - Sole and upper leather
  - Leather boots and shoes
  - Harness and saddles
  - Leather clothing
- Soap and soap powders
- Engines and motors operated by steam, gas and electricity, or other motive power and their accessories
- Metal and wood-working machinery
- Oil well casing
- Oil well drilling implements, machinery and accessories thereof
- Steam boilers
- Turbines
- Condensers
- Pumps and accessories thereof
- Electrical equipment:
- Crucibles
- Emery
- Emery wheels

Tool steel
High speed steel
Alloy steel
Machine tools
Steel hardening materials
Fertilizers:
  Cattle and sheep manure
Nitrate of soda
Poudrette
Potato manure
Potassium salts
Land plaster
Potash
Cyanamide
Phosphoric acid
Phosphate rock
Superphosphate
Chlorate potash
Bone meal
Bone flour
Ground bone
Dried blood
Ammonia and ammonia salts
Acid phosphate
Carborundum and artificial abrasives
Copper:
  Ingots
  Bars
  Rods
  Plates
  Sheets
  Tubes
  Wires
  Scrap
Lead and white lead
Tin, tin plate, tin cans and all articles containing tin
Nickel
Aluminum
Zinc
Plumbago
Platinum
News paper, print paper, wood pulp and cellulose
Ash, spruce, walnut, mahogany, oak and birch woods
Industrial diamonds

Should Exemption for Medical Students Apply to Engineers?

In view of the suggestion that students in engineering colleges be exempted from draft in the National Army, the following memorandum from the provost marshal general to the governors of all states, exempting medical students and hospital internes, is timely:

"The President prescribes the following supplemental regulations governing the execution of the selective-service law:

"First—Hospital internes who are graduates of well-recognized medical schools, or medical students in their fourth, third or second year in any well-recognized medical school who have not been called by a local board may enlist in the Enlisted Reserve Corps provided for by Section 55 of the National Defense Act under regulations to be issued by the surgeon general, and if they are thereafter called by a local board they may be discharged on proper claim presented on the ground that they are in the military service of the United States.

"Second—A hospital interne who is a graduate of a well-recognized medical school, or a medical student in his fourth, third or second year in any well-recognized medical school, who has been called by a local board and physically examined and accepted and by or in behalf of whom no claim for exemption or discharge is pending, and who has not been ordered to military duty, may apply to the surgeon general of the Army to be ordered to report at once to a local board for military duty, and thus be inducted into the military service of the United States, immediately thereupon to be discharged from the National Army for the purpose of enlisting in the Enlisted Reserve Corps of the Medical Department. With every such request must be inclosed a copy of the order of the local board calling him to report for physical examination (Form 103), affidavit evidence of the status of the applicant as a medical student or interne, and an engagement to enlist in the Enlisted Reserve Corps of the Medical Department.

"Upon receipt of such application with the named inclosures the surgeon general will forward the case to the adjutant general with his recommendations. Thereupon the adjutant general may issue an order to such interne or medical student to report to his local board for military duty on a specified date, in person or by mail or telegraph, as seems most desirable. This order may issue regardless of the person's order of liability for military service. From and after the date so specified, such person shall be in the military service of the United States. He shall not be sent by the local board to a mobilization camp, but shall remain awaiting orders of the adjutant general of the Army. The adjutant general may forthwith issue an order discharging such person from the military service for the convenience of the Government.

"Three official copies of the discharge order should be sent at once by the adjutant general to the local board. Upon receipt of these orders the local board should enter the name of the man discharged on Form 164A and forward Form 164A, together with two of the certified copies of the order of discharge, to the mobilization camp to which it furnishes men. The authorities at the mobilization camp will make the necessary entries to complete Form 164A, and will thereupon give the local board credit on its net quota for one drafted man."

Maximum British Prices for Superphosphates

An order of the Minister of Munitions which went into effect on Aug. 21 fixes maximum prices for superphosphates, according to *Commerce Reports*. These maxima are based upon the percentage of tribasic phosphate of lime rendered soluble in water, and vary from $22.50 per long ton for superphosphates between 15 and 16 per cent to $45.25 per ton between 44 and 45 per cent. Lloyd's List states that these prices, for all qualities, are for orders placed for delivery during December, 1917. In the case of orders placed for delivery during other months the prices are to be reduced or increased 1 shilling ($0.24) per ton per month according as the months precede or follow December, 1917.

For the purposes of the order "superphospate" means superphosphate of lime manufactured from mineral phosphate, but does not include basic superphosphate, bone superphosphate, dissolved bones, bone meal or bone compound, guanos, or compound manures.

Far Eastern Tin Supply

Present indications are that the Hongkong tin market will be stripped of its supplies in a few months as a result of the market advance in price in consuming countries and slow supplies from other producing countries, according to *Commerce Reports*. Exports for the first half of the present year are at the rate of about three times the highest record in the history of the trade and in much larger proportion compared with the average.

The exports, up to the limit of the total production, are merely a matter of price. While prices of tin the world over have been high for some time and have stimulated considerable exports from this field, the high exchange value of silver has operated against this field and in favor of others where the relations of local currency to gold was more favorable. The extraordinary demand at high prices has so denuded the Straits market, however, that buyers have turned to the Hongkong field perforce. Allowing for delays in supplies from the mines and for a modicum of speculation, there seems to be no question but that at present supplies of tin in the Far Eastern markets generally are barely equal to the demand.

Investigation of Defective Small-Arms Ammunition at Washington

Hearings thus far before the select committee of the House of Representatives to probe into the matter of defective small arms ammunition furnished troops under General Pershing and other units of the American armed forces have failed to disclose responsibility for the defects. The hearings are at present suspended while the evidence taken to date is printed, so that members of the committee can study the problem before them.

It has been developed in the hearings, however, through the testimony of Col. George Montgomery, commanding officer at the Frankford Arsenal at Philadelphia, where the rifle and machine gun ammunition in question was manufactured, that the arsenal continued to use a formula for the make-up of primers which was inferior to that in use by a majority of private manufacturers. This was done, the evidence discloses, in spite of the recommendation that it be discontinued.

There is a strong likelihood that the present special session of Congress will adjourn without the committee having reached the bottom of the ammunition probe. Experts have drawn the inference from the hearings also that the method of testing the various batches of cartridges turned out for small arms at the arsenal is not satisfactory, but are completely at a loss to suggest a better method.

It has been and is now the custom to take at random a number of cartridges from each batch turned out at the arsenal and test them by firing. On one day the results would be satisfactory, and only a small percentage of misfires and hangfires would result. On the succeeding day it was quite possible, the evidence showed, that a sufficient number of defective cartridges would be found among those tested to indicate that the entire batch manufactured on that day was unsatisfactory. Yet all were made up from the same formula and with the same materials. Expert witnesses before the probing committee attributed it to luck and nothing else that the testing cartridges on one day would test out with a low percentage of misfires and hangfires, with a much larger percentage of defective shells appearing on another day.

Colonel Montgomery has been the chief witness before the committee thus far. Some of his assistants from the arsenal have appeared, but have done nothing more than repeat his testimony in greater detail.

Some of the defects uncovered by use of the ammunition has developed, the evidence shows, from subjecting it to more rigid tests than are required by the regulations. Some of the ammunition furnished units of the various armed forces of the country has been allowed to stand in water or become saturated in some way and remain exposed for a longer period than they are supposed to stand and remain satisfactory. This had been unavoidable in a great many instances, however, it was shown.

The great fault with all the ammunition rejected by the Pershing forces and other commands of the army, navy, Marine Corps and National Guard is with the primers. This aspect of the situation has taken up more time than any other brought out at the present hearing.

It was developed that an inferior primer mixture has been in use for many months in the Frankford Arsenal, in spite of recommendations from Colonel Montgomery that it be abandoned, while private manufacturers of small arms ammunition were using better formulas. The primer formula to which Colonel Montgomery objected was one containing free sulphur as one of its constituents. Fulminate of mercury in place of the sulphur was urged, but for some reason not yet developed it was not adopted.

The combination of the free sulphur with potassium chlorate in the primer used at the arsenal worked well for some time, but the supply of potassium chlorate was not good after the United States was cut off from the German supply. Potassium bromate combined with the sulphur to deteriorate the shells.

Due to the testing method, a great many millions of shells were issued to army and navy units before it was known that they were defective. The defects to the chemical difficulties would not, of course, appear in newly finished shells at all, and it was largely due to these facts that the poor ammunition found its way out of the arsenal.

When the defect in the primer manufacture became known it was necessary to purchase millions of primers from one of the principal private manufacturers to maintain the war-time rate of production at the arsenal. Before it is possible for the arsenal so to change its formula and primer-making plant and system, it was necessary to make hurry demands on the private manufacturer for twenty-five million primers, then for ten million more, and later for another ten million.

Poor antimony sulphide figured to some extent in the defects found in the cartridges turned out. This, it was explained by Col. Montgomery and other army officers and experts attached to the arsenal, was due to the fact that the selection of this chemical was not on a good basis so far as purchases for the United States government are concerned, and the supply was well "picked over" before American government purchases were made.

Poor copper also was a factor, the evidence thus far taken has shown. The reason for obtaining or using the poor copper was not gone into in great detail, and has not yet been entirely cleared up to the satisfaction either of the committee or of the army.

On account of the deterioration of the shells after they left the arsenal—the deterioration due to the combination of free sulphur with the other elements of the primer formula—it was shown that it was impossible to locate bad small-arms shells before they were issued to the army or navy. Several samples of each batch issued are kept, however, with the dates of manufacture, the date of issue, and the organization to which issued. In this way it was possible to re-test samples of a batch said to be defective. This system and investigations following it, it was testified, enabled the arsenal authorities to discover that some of the ammunition had been exposed to greater rigors in active service than the specifications under which the shells were manufactured demanded. Further test of most of the batches questioned, however, developed the fact that deterioration in the primers, due to the use of the sulphur formula, was responsible for the high percentage of defective shells.

United States Chamber of Commerce Mobilizes American Business

American business was mobilized at Atlantic City, N. J., on September 17 to 21, when the leaders in every industry in the United States gathered there to see how the industrial, commercial, and financial resources of the country could best be utilized to aid the government in bringing the war to a successful conclusion, as well as aid business itself to come to a definite understanding as to its future in connection with the conduct of the present war.

Some of the best work done at the convention, aside from the speeches which inspired those who were present, was done by the Committee on Resolutions, which included men in every line of commerce, industry and finance, as well as men from every section of the country. It was freely pointed out in the convention, which was called the War Convention of American Business, that no committee on resolutions in any assembly of the Chamber of Commerce of the United States had ever included a more representative body of American Business than the committee which served so laboriously at this Atlantic City convention.

The background of the convention was that American Business since the declaration of war with Germany, and since the competitive buying of supplies in the United States for the Allies, for the United States, and for private business, had thrown American industry into chaos.

The situation was very clearly defined by Mr. Waddill Catchings, chairman of the Program Committee of the convention, and who is also chairman of the Committee on Co-operation with the Council of National Defense, on behalf of the National Chamber. Mr. Catchings, formerly a president of a number of iron and steel companies, left those industries upon the declaration of war, declaring he did not care to make money out of the war, and placed his services at the hands of the government in Washington, so that because of his previous experience in the industries in which he has been connected, and because also of his experience in close touch with the Council of National Defense, he was in the opinion of the delegates to the convention well qualified to analyze the present condition of business as it affects government and private industry jointly.

Newspaper reports did not carry a complete report of Mr. Catchings' address to the convention, nor of the resolution which was adopted by the Chamber of Commerce of the United States at the War Convention which was inspired by Mr. Catchings' address and the background which made necessary the calling of the war convention. Never in the history of American Business have such resolutions been passed at any convention such as that of the National Chamber just ended. Leaders of industry, commerce and finance, supported by less known men from every section of the country, declared in their resolutions that at the earliest possible moment all the purchasing of the government for the war should be concentrated in one body. They declared for the first time in the history of American industry that it is right, proper, and necessary that the government should have the power to fix prices on all materials needed for the conduct of the war as well as all materials affecting the public interest for the government itself and for the public at large. It was declared that the government should by right of necessity have the power of fixing the priority of shipments. It was declared that American business is ready for heavy taxes, for the dissipation of its savings, and that it is ready to turn over its plants to the government, under government control if necessary, and do any and every other thing which may be necessary for the successful conduct of the war.

Important Waterpower Resolutions

One of the features of the convention was a resolution in regard to waterpower which was discussed by S. A. Osborne, vice president of the Westinghouse Company. There was an extended discussion upon the subject, most of which tended toward committing the Chamber of Commerce of the United States to an attempt to urge upon Congress the desirability of the enactment of some of the waterpower bills which have been pending in Congress for several years. It was declared that Congress should without delay enact this legislation, especially the legislation pending which would develop the waterpowers at sites now under federal control. There were two resolutions upon this subject, the other one, tending especially toward irrigation projects. The first resolution requested that the directors of the Chamber of Commerce of the United States be asked to appoint a special committee to investigate the present need of waterpower development and the character and extent of legislation required and to report to the National Chamber as soon as possible. The Committee on Resolutions suggested that the convention endorse the request that this resolution should be referred to the Board of Directors of the National Chamber; and the Committee on Resolutions also suggested, which suggestion was also endorsed by the convention, that the other resolution on waterpower should be referred to the Board of Directors.

It is understood in Washington since the convention adjourned, that a special committee on waterpower will be appointed in accordance with the suggestion in the resolution which asked for such a committee and into the hands of this committee-to-be, no doubt, will be committed the other waterpower resolution dealing with irrigation.

The convention, according to those who were present, was an inspiring occasion. James A. Farrell, president of the United States Steel Corporation; John D. Ryan, president of the Anaconda Copper Mining Company; Henry Bruere, vice president of the American Metal Company; E. H. Huxley, of the United States Rubber Company, and many other leaders in industry addressed the convention. Herbert C. Hoover, the United States Food Administrator, delivered an address in which he spoke almost wholly of food, but those who are familiar with the so-called Food Bill which was passed by Congress realize that the things he said could be done by the government in regard to food can be done by the government very largely in regard to fuel. He described the complete control of the government over food. Very strong resolutions of support for Russia were passed, and especially in regard to further financial support for that new democracy.

Outline of Present Business Conditions

The present chaotic situation in American business and the steps necessary to bring order out of confusion were well presented in an address by Mr. Waddill

Catchings. We give herewith the principal features of his address.

The committee on co-operation with the Council of National Defense, of which I am chairman, has for the last few months been in intimate contact in Washington with the great industrial problems which have arisen as a result of the large purchases which our Government is making. It is said that our Government will expend for war purposes for our armies and for the allies during the next year $19,000,000,000. You get some idea of the effect on business of this great demand if you have in mind that the entire turn-over of all the subsidiaries of the United States Steel Corporation, the gross volume of their business in the year 1916, the Carnegie Steel Company, the American Steel & Wire Company, the Tennessee Coal, Iron & Railroad Company, and all the rest—the entire value of their gross turn-over was $853,000,000.

Our Government is therefore going to lay a demand upon business which is more than twenty times the output of all the subsidiaries of the United States Steel Corporation.

You have an opportunity at home of seeing the effect on business of these great purchases, the effect of the withdrawal of material and labor. These interests essential to the industrial fabric are unable at the present time to secure the materials which they need. The interests which are not essential to the industrial life are faced with the great problem of what they are going to do during these times to carry their structure from the present over into the future.

High Prices Due to Competitive Bidding

The result of the competitive bidding by the Government for the vast quantities of materials and supplies which they need, and of the competitive bidding by business for what is left, has produced high prices. These high prices have produced great discontent throughout the country. Our people have not viewed with unconcern the acquiring of great riches in this time of national sacrifice and distress. There are great labor difficulties arising in all sections of the country. We are having here the same experience which England had in securing the exceptional effort of labor when an indirect effect of that exceptional effort was the creation of great riches.

These are problems which are developing throughout the country, and they are problems which it is the expectation of the program committee and of the committee on co-operation with the Council of National Defense, will be discussed fully in this meeting. They are problems not only of the purchase of supplies by our Government, but the purchase of the supplies in such manner as not to interfere with the essential industrial life of the nation; the purchase of these supplies in such a manner as not to unsettle established social and economic conditions.

You know that when business men are told that they should not charge a high price for materials and supplies, that that is entirely ineffective unless some action is taken to create a different condition. As long as there is a great demand, so long will prices rise; and it is idle for us as business men to respond to the patriotic addresses that are made unless we carefully discuss how we can carry into effect the ideas that are expressed and to make them effective.

It is for you to determine if this country has vested in our Government at Washington sufficient power in times of peace to settle these extraordinary problems which have arisen in connection with the war as a result of these vast purchases. You have in mind, no doubt, that the effort of our Government in connection with the purchases of munitions of war is focussed on the war industries. It is a great disappointment to us that Mr. Scott, the chairman of this board, has not been able to be here to-day to set forth to you the great work which the board has done. It is for you to determine whether this board, with the powers it has under existing statutes, can meet the situation when it is developing. In this great democracy of ours powers must be vested in the Government before the Government can act, and it is not possible for the authorities in Washington to act in regard to the problems existing as might seem best to them. It is only possible for them to act in accordance with the statutory power which has been given to them. It is for you to determine here whether the War Industries Board and our Government at the present time have power necessary to solve these great problems which are arising from this unprecedented demand upon business.

You no doubt have in mind that the War Industries Board was created by the Council of National Defense; that the Council of National Defense has no authority under the law to act; that the Council of National Defense is a body that was created in time of peace to investigate, report and give advice. The War Industries Board has been created by that body. It can have no power which was not possessed by the body which created it. The War Industries Board is rendering great service to-day in advising Government officials in bringing centralization to the Government purchases, but the purchasing for the Government to-day is being done just as it was done in times of peace by the many bureaus and departments of the War Department and of the Navy Department. Independent purchases are being made to-day by the signal corps, the engineer corps, the naval corps and all of the various quartermasters. The War Industries Board is doing all it can to bring about co-operation between them, but any careful study of the situation in Washington will lead you, I think, to the conclusion that what they are able to accomplish, however great it may seem, is not great in comparison with the work which is to be done.

Creation of Government War Board Necessary

The committee of which I am chairman has been studying the situation in Washington for months, and I say to you without hesitation that without loss of time our Government should be given power to create a war board similar to the minister of munitions in England. This should be a board which would assemble under one control the trained buyers of the various departments of the Government. It should be drawn from the various competing bodies and gathered together; but these competing bodies of Government officials should be reenforced by men from civilian life. Most of those men are probably in Washington at the present time advising the Government as best they may, but these men should be no longer advisors; they should be in the actual service and doing actual purchasing for the Government.

The Government is in contact with business to-day on a scale never heard of in our Government before. Army and navy officers who are trained with special work and who have had some experience with special buying in the past are called upon to deal with these enormous problems. Our committee says unhesitatingly that these men should be relieved for service at the front, except such of them as are necessary to retain experience from what has been done. All who have experience should be called into the Government service. Such a board would have to have power to determine prices when negotiation between buyer and seller can no longer take place because of the unprecedented demands for material; and as to those materials which are necessary for the national defense, those materials which are necessary for the preservation of our essential industrial life, where negotiations between buyer and seller can no longer be had, our committee says unhesitatingly that the Government should have authority to determine the price upon some fair basis. Such a body would have to have power to determine priority, the order of distribution of the available supplies.

We say to you that you cannot expect the material of our country, which is not equal to the entire demand, to go where it is most needed into national defense or for the preservation of our essential industrial life by mere competitive bidding. We say to you that the experience that has been acquired should be made use of here. We say to you that a careful examination of the work that has been done by the ministry of munitions, the manner in which they have had to determine priority, the matter in which they have to determine prices, the effect of all that upon the British life, the orderly manner in which business is run in Great Britain to-day, will convince you, upon thoughtful investigation, that it is necessary.

Our committee is glad to say that the independent investigation of the price control committee recently formed has led them to the same conclusion. The Chamber of Commerce appointed a committee on which were important men from all sections of the country. They represented all phases of business life. They came to Washington without knowledge of the situation there, with probably as many different points of view as there were different men on the committee. They sat down and studied the situation very carefully. They threshed out these problems and worked together upon them for days, and they came to a unanimous conclusion. The Wall Street man and the farmer, the lawyer and the manufacturer, the distributor and the merchant came to a unanimous conclusion, and that is carried forth to you in Referendum No. 22.

Our committee says to you that no delay should be made in reaching conclusions of this sort. It is a common statement in Washington that our American people are not going to wake up to what is meant by the war and what it really means to bring order in business until the casualty lists begin to come in. My committee says to you that you have here the opportunity in this convention of facing the facts as they actually are, of studying those facts and discussing them among yourselves and of reaching conclusions at a time which may save many dollars and may save a great many precious lives.

Objections to Government Regulation Answered

If you say that the Government should not interfere with business, our committee says that the answer is that the purchasing of $19,000,000,000 of material and labor is an interference with business, and that the suggestion is not that there be no interference, but that there be orderly interference, and not disorder.

If you say that the loss of trade should be taken into consideration, our committee says that the answer to that is that when the entire industrial life of our nation is concentrated upon the single purpose of winning the war, there is no loss of trade.

If you say that the machinery of the Government should be developed and used for the purposes of the War and Navy Departments, we think the answer is that these are temporary problems, that business is asked to give the Government great power temporarily; that the situation which we are asked to meet exists only during the war, and that therefore a temporary structure should be created so that at the end of the war we can so far as possible return to normal conditions.

If you say that the situation is too big, too complicated, that our Government cannot undertake the regulation of prices or the regulation of priorities, we say to you that chaos exists in business to-day, and that order must be brought out of that chaos. If our industrial energy is to be centered behind winning the war, these problems must be solved.

We believe it is entirely appropriate for this convention to discuss these matters. Under our democratic system, the necessary authority and power must be conferred upon our executive officers. These are problems with which you are familiar, if any men are familiar with them. You know the conditions existing throughout the country. You know whether our railroad machine shops have men which they need and whether those men have been drawn to go to munition plants. You know whether the public service companies of the country are able to bid for material and supplies at the present time. You know whether labor is discontented and whether there is orderly conduct of business at the present time.

A clear illustration of the situation is furnished in the manner in which the engineering department, the ordnance department, the medical department, the quartermaster department and the navy department are doing their work. The private concerns are doing work on Government "cost plus profit" contracts, and all are working independently. All are competing one with another for labor and for material.

You are the men who know whether those conditions exist throughout the country. Our committee says it is not right for American business to wait for the United States at Washington to suggest these problems which are to be worked out. There are enormous problems in Washington. The problems of business are but a portion of those problems. You cannot expect the Government officers to recognize our problems with the same ease and facility that you can become acquainted with them.

Our committee believes that this convention offers a very great opportunity; that if American business men in this mass meeting discuss these problems, get a realization of the remedy which may be applied, you

can bring order out of this chaotic condition at a much earlier date than it will be brought by the natural course of events. That can be done if you approach our Government and point out that business is willing to submit to control in these times; that you do not insist upon full freedom of action when winning the war is at stake. If that is done, co-operation can come about between business and the Government which cannot exist at the present time. Business will no longer be on the opposite side of the table in any negotiation. Business can sit side by side with the officials of the Government in an effort to solve these problems.

These are the problems which it is the hope of the committee you will discuss during these days. These are the problems as to which the committee hopes you will pass resolutions which shall give expression to the National Chamber of what action business men desire taken.

Important Resolutions Passed

The great war convention of the Chamber of Commerce of the United States, characterized by the thousands who were present as the greatest convention in the history of the organization, came to an end with the passage of some of the most remarkable resolutions ever passed by American business.

A complete digest of these documents would be too lengthy for presentation, and only the most pertinent can be mentioned. The following "Declaration of the War Convention of American Business," sounded the keynote.

"The people of the United States, in defense of the Republic and the principles upon which this nation was founded, are now taking their part in the world war with no lust for power and no thought of financial or territorial gain.

"The issues at stake in this stupendous struggle involve the moral ideals and conception of justice and liberty for which our forefathers fought, the protection of the innocent and helpless, the sanctity of womanhood and home, freedom of opportunity for all men and the assurance of the safety of civilization and progress to all nations great and small.

"Speed of production and mobilization of all our national power mean the saving of human life, an earlier ending of the designs of autocracy and militarism, and the return to the peoples of the earth of peace and happiness.

"Undismayed at the prospect of great taxes, facing the consumption of its accumulated savings, American Business without hesitation pledges our Government its full and unqualified support in the prosecution of the war until Prussianism is utterly destroyed.

"Assembled on the call of the Chamber of Commerce of the United States and representing more than half a million business men and every industry in every State in the Union, this Convention promises to our people that Business will do all in its power to prevent waste of men and material and will dedicate to the Nation every facility it has developed, and every financial resource it commands on such terms and under such circumstances as our Government shall determine to be just."

The following important recommendation was made regarding water power legislation:

WHEREAS, the scarcity of coal and other fuels during the past year, with the resulting disastrous effect on every branch of commerce and industry, calls renewed attention to the great importance of developing at the earliest possible day unused water power in order to make available for public service an inexhaustible power not requiring the consumption of exhaustible fuel, and,

WHEREAS, Increased use of water power, because it furnishes a cheap and reliable power of general application, reduces the drain on our stores of mineral fuel, which when consumed can never be renewed, and thereby relieves a great stringency bearing on national defense due to the imperative need for fuel for both land and water transport and the manufacture of war supplies, Be it therefore

RESOLVED, That Congress should without delay enact legislation necessary to the early development of water power at sites now under Federal control, on terms which will advance and protect the public interest. Also

RESOLVED, That the directors be requested to appoint a special committee to investigate this present need of water power development and the character and extent of legislation required and report to this Chamber as promptly as possible.

Briefly, the resolutions passed by the convention were as follows:

(1) A general resolution pledging the support of business to the war as given above.

(2) A resolution declaring that at the earliest moment all the purchasing of the government should be concentrated in one body and that the government should have the power to fix prices on all material needed for the conduct of the war as well as all materials affecting the public interest, for the government itself and for the public at large.

(3) That employers and employees should not attempt to change existing standards of work during the period of the war.

(4) That a federal board appointed by the President to adjust disputes during the course of war. That there should be no strikes or lockouts during the adjustment of such disputes. The committee on resolutions refused to report a resolution that would try to tell labor what it must do and the convention took the attitude that American business should merely invite the co-operation of labor.

(5) A resolution of sympathy with Russia was passed.

(6) The co-operation of the retail merchants of the United States to the Commercial Economy Board was pledged and the usefulness of the employment service for the Department of Labor was endorsed.

(7) The convention endorsed the action of the directors in creating a foreign commission to proceed abroad and study and report upon the means whereby business may adapt itself to the problems that will arise during and after the war.

(8) The convention requested that every organization should call a war meeting before Nov. 1 to take to these organizations the lessons of the convention.

(9) The daylight saving plan, it was declared, would conserve the nation's supply of coal.

(10) The improvement of public highways for military roads and in order to move foodstuffs economically was moved.

(11) The United States Government was urged to take whatever action may be necessary to keep the American dollar on a par with exchange in every other country of the world. The Chamber urged the business men of the country to promote the sale of future Liberty Loans and especially urged that employers assist their employees to subscribe to such loans.

Annual Meetings of Institute of Metals and American Foundrymen's Association

Enthusiastic Gatherings Discuss Important Aspects of Metallurgy

A large and enthusiastic gathering of engineers and foundrymen interested in non-ferrous alloys occured at the annual meeting of the American Institute of Metals held in Boston, during the week of Sept. 24, 1917. The first day was held as a joint meeting with the American Foundrymen's Association, and its account will be found on page 382 under that head.

The technical sessions occupied the mornings thruout the week, the afternoons being occupied by various social affairs and plant visitations, such as a boat ride about Boston Harbor, American League ball game, theatre parties, luncheons and banquets, a trip to such interesting places as the West Lynn plant of the General Electric Co., Waltham Watch Co., Massachusetts Institute of Technology, and a numerous list of notable foundries and industrial plants. The Annual Banquet was held at the Copley-Plaza Hotel on Thursday evening, and as usual was one of the great features of the annual meetings. John A. Penton, of Cleveland, delivered the main address in which he discussed conditions in France during the war, he recently having been privileged to spend three months inspecting munitions works, steel plants and rolling mills. Judge Charles F. Moore also gave a very clever talk on "Dollars and Sense."

MELTING PRACTICE, ESPECIALLY IN ELECTRIC FURNACES

The first technical session of the Institute covered Melting and Casting. The present acute situation in crucibles was not only reflected in papers by **A. V. Bleininger** of the Bureau of Standards on "Raw Materials Used for Crucibles," and **M. McNaughton** of the Jos. Dixon Crucible Co. on "The Crucible Situation," but also by two other notable papers on electric furnaces for melting high-zinc alloys.

Mr. McNaughton took issue with Prof. Bleninger's statement that the question of the manufacture of satisfactory crucibles from American clays and graphite could be solved in the laboratory. Even admitting the enormous importance of such researches in indicating the proper procedure, still the final test must always come in the actual manufacture and use of the crucibles on an industrial scale. Owing to the great difficulty of making crucibles with clays and plumbago other than the time-tried imported materials, makers had been insisting that melters do as much work as possible in the smaller-sized containers. Even so, little decline in the demand and use for large sizes was noticeable from the rolling mills, consequently he thought the average size of crucible in use is about the same as before the war.

Mr. **G. H. Clamer** of the Ajax Metal Co., described the melting of yellow brass in a new form of induction furnace, developed from the Snyder type, and called the Ajax-Wyatt. These furnaces which have been installed in five plants in America contain an upper chamber, mounted on trunions and with spout and cover very much like any tilting crucible furnace. However, a triangular casing is bolted to the bottom, which contains a rectangular passage leading from the sides of the furnace laboratory and meeting at the bottom, much like the letter V. Thru the center of this triangle is placed the core and primary of a single phase transformer, the secondary circuit consists then of molten metal in the V-trough and chamber above. The furnace is started with enough molten metal to fill the channels and bridge across their top; the current induced by the transformer action will cause rapid circulation by pinch, motor, and Joule effect, which will transmit the heat generated mainly in the trough up into the crucible for melting additional cold metal. The design of the furnace is such that the circulation induced by the heating currents is sufficient to replace hot metal with cooler before it is locally superheated beyond the boiling point of the zinc content. By the very nature of the furnace, however, it is almost essential to operate continuously, with a uniform mixture; since the power input is practically uniform as long as a molten metal circuit remains, which indeed is reserved in the furnace after each pouring.

PRESENT STATUS OF THE BRASS MELTING FURNACE

A very inclusive paper by **Dwight D. Miller** on "The Electric Furnace and Nonferrous Metals," excited much favorable comment. Mr. Miller's paper noted the very rapid rise of the electric steel furnace in America; the Halcomb Steel Co. having built and operated the first in the western hemisphere in April, 1906. Up to 1914 there were only 19 furnaces installed, and some of these were not operating. The first of 1915 saw 41 electric furnaces, by 1916 the number had grown to 73, while on Jan. 1, 1917, no less than 136 electric furnaces were in use melting steel or under contract. The total number then in use thruout the world in steel works, according to the best information attainable, was 471, of 17 different makes.

After a section of the paper in which he classifies and briefly describes the more important furnaces in use, he points out the many obvious advantages of the electric furnace in the non-ferrous field, the reason why this type can make progress against cheap coal fuel, being of course that the heat cost is but a small percentage of the total cost of the finished product. Then too, the efficiency of heat transfer in a well designed electric furnace is so much better than that of the ordinary melting hole that the cost per B.t.u. hardly tells the total story. On the other hand, ordinary steel-melting furnaces do not handle alloys high in zinc like the normal brasses, without a high metal loss. This not only costs money, but the zinc vapor produced causes great electrical disturbances, and in many cases prevents the further operation of the furnace.

Mr. Miller listed the following furnaces as having been designed and under experimentation: The Gillett Furnace, of an indirect arc type; the General Electric Furnace, of a "smothered arc" type; the Conley Furnace, which uses the crucible as the resistor; the Northrup furnace, an induction furnace using an oscillating current of high voltage; the Hering "pinch effect" furnace; and the Bennett furnace, now being developed by the Scovill Manufacturing Co.

No less than five different types of electric furnaces are now melting copper-zinc alloys, with variable results, as follows: The Ajax-Wyatt furnace, described by Mr. Clamer as above; the Foley furnace, similar to the first mentioned; the Bailey furnace, described in METALLURGICAL AND CHEMICAL ENGINEERING, July 15, 1917, page 91; the Rennerfelt arc furnace; and the Snyder induction furnace. This portion of the article giving details of practice on zincy metal is reserved for future publication in full.

In the discussion of the paper, **Dr. H. W. Gillett** said that he was unable to present definite figures regarding the furnace which he was trying to develop because it was not yet in definite shape. However, it had melted about 100,000 lbs. of metal with variable results, altho in every trial in melting scrap 2 or 3 per cent more metal reached the ingot than the best coke practice. Using alloys containing up to 30 per cent zinc the ingot was one per cent or more higher in zinc than in coke melting. The power consumption was very good, and the principal difficulty was that the zinc distilling from the bath tended to condense as powder at the electrode openings, finally freezing these in place and preventing their adjustment.

W. H. Parry of the National Meter Co. described in a humorous way the barrels of grief he encountered in trying to operate a reclamation plant built by a firm of near-engineers who couldn't tell him how to run it. After telling of his many failures to produce any metal using various fluxes, he at last acquired a furnace man from a metal refinery, who at last was able to produce metal without the use of flux of any kind, containing nearly all the copper, tin and lead and about half of the zinc contained in the spillings, turnings, slags, and drosses charged.

NEW ALLOYS AND THEIR USES

The second technical session brought forth several interesting papers. "The Present Status of Tin Fusible Plug Manufacture," by **Dr. G. K. Burgess** of the Bureau of Standards was read by title. Mr. **Elwood Haynes** described the invention and perfection of his alloy "Stellite" in a very interesting address. Mr. Haynes had with him the various pieces of cutlery and hardware which he exhibited at the recent meeting of the American Chemical Society, and which excited a great deal of interest.

Mr. **H. J. Roast** of Jas. Robertson Co., Ltd., described the manufacture of "Shrapnel Bullets." The English government requirements are for an alloy of 12½ per cent antimony, 87½ per cent lead, with a variation of ± 0.25 per cent in composition. The balls are ½ in. in diameter, and weigh 41 to the pound; the size and shape being very closely inspected. After trying extrusion of cast bars, it was found that casting in water-cooled molds, 150 at a time, gave a more uniform ball, both as to size, weight and chemical composition. In this connection the author emphasized again the need of a standardized and reliable method of analysis for antimony, as the probable error in some methods was found to be greater than the tolerance allowed in the specification.

The discussion of Mr. Roast's paper brought out the fact that constant stirring was essential to prevent segregation, even in eutectic alloys. Stirring which caused rising currents is essential, as rotating currents actually cause segregation. Improperly melted, the shrapnel metal segregates so badly as to vary from 11 to 19 per cent antimony.

"Recent Industrial Uses of Aluminum" were noted in a short paper by **F. G. Shull** of the Aluminium Co. of America. He mentioned the use of plain foil for wrapping candy, lining food containers of wood, paper or metal, and as seals for glass jar caps and bottled goods. Quantities were being absorbed in the construction of electrical condensers. The development of the art of printing and embossing such foil had been interesting, and was accounting for a large increase in consumption. The perfection of autogenous welding had opened up a wide field in the chemical, brewing and food industries, in fact, everywhere where one-piece metallic, non-rusting containers for liquids were desirable. Seamless tubing had also been produced for such service. Where drawn pure aluminum rods had been extensively used for stock in automatic machine products a high-aluminium alloy which could be rolled into rods was being substituted, the more thorough mechanical kneading of the rolling process giving a much more homogeneous and desirable metal. A die-cast piece, either plain, or with subsequent hydraulic compression, is now being substituted for automatic machine products involving the production of a large amount of scrap or turnings. Compressed castings have been extensively used in time devices for shrapnel, being of very high strength, absolutely sound, and easily machined.

Mr. **A. L. Stillman** read a paper on "The Briquetting of Non-ferrous Light Metal Scrap," in which he stated that fluxes or binders should not be used in metal briquettes unless, as in bronze, the highest available pressure would not cause a cohesion, metal to metal. Most white metals and brasses, however, if properly briquetted, can be welded together into "heavy scrap" having a density from 65 to 85 per cent that of the corresponding ingot metal. This is effected by slow multi-stage compression, the first squeeze at a moderate force interlocks the fragments and eliminates the entrapped air, while the following final pressure of 33,000 lbs. per sq. inch forces points of the particles within the range of inter-molecular forces, actually forming a weld.

METAL-TESTING SESSION

A number of important papers were read on the various physical tests of alloys, which space limitation admits of barely more than a mere enumeration. Mr. **W. M. Corse,** secretary-treasurer of the Institute, read a paper on "Comparative Tests on Test Bars and Actual Castings." **E. W. Hagmaier** of the Superior Rubber Co. read an interesting paper on speedy analyses of brass, bronze and babbitt, especially designed for routine, commercial determinations. The methods were especially interesting, as the author explains the de-

tails of manipulation which really develop the speed in chemical analyses.

The co-operation of the Bureau of Standards with various foundries were shown in two interesting papers, one by **C. P. Karr** on "Tests of 88-8-4," and another by **H. S. Rawdon** on the "Corrosion of Brasses of the Muntz Metal Type." Mr. Rawdon pointed out that brass of the type 60 copper and 40 zinc (Muntz metal) which is used commercially in a variety of forms, e.g. wrought bolts, sheathing, condenser tubes, extruded forms, etc., often show a kind of deterioration by which the metal changes its color to copper-red and becomes very weak and brittle, although the shape, and size apparently remain unchanged. This change of properties is due to a selective corrosion of the alloy, which has a duplex structure, when exposed to the action of some electrolyte—particularly sea water. This type of corrosion has been recognized by manufacturers and users of brass for some time. The study of such types includes bolts, boat sheathing, condenser tubes, and parts which were corroded while under stress. The examination of the microstructure shows the method of the attack; the zinc-rich constituent being electrolytically "leached out" leaving a skeleton of pulverulent copper in its place so that the piece becomes very weak and brittle. Later, the second constituent may be attacked so that the whole specimen is converted into pulverulent "copper"—the sample becoming so weak that it can be broken into fragments in the fingers. Conditions which accelerate this type of corrosive attack are: The microstructural composition of the alloy, contact with strongly electro-negative metals, the effect of certain adhering deposits of basic zinc chloride resulting from the corrosion, the thoroughness of the annealing which the sample has previously received, the temperature of the electrolyte, and the stresses to which the specimens are subjected during the corrosive attack.

METALLURGY AND METALLOGRAPHY

The session on Friday, devoted to Metallurgy and Metallography was of the greatest scientific interest. Mr. **Zay Jeffries** of the Aluminum Castings Co., read an important paper on "The Amorphous Theory in Metals"; while Mr. **H. M. Williams**, of the National Cash Register Co., described a long research into the causes of a very bothersome property of certain zincy die castings—namely, their slight expansion with age. Both of these papers we hope to present in extenso at a later date.

Mr. **K. C. Li** of the Wah Chang Mining & Smelting Co., read an interesting paper on "The Metallurgy of Antimony," in which he described the methods of production of crude antimony, antimony oxides, and metallic antimony. A number of interesting uses were listed, it entering as metal into the composition of Babbitt metal, type metal, Britannia metal, battery plates, toys, siphon tops, cable sheathing, shrapnel bullets and hard lead. Antimony compounds are used in enamels, rubber vulcanizing, pigments, glass making and safety matches. **Prof. D. J. Demorest** described experiments which he had performed in his laboratory at Ohio State University leading to the electrolytic production of antimony direct from crude antimony, or Sb_2S_3, eliminating the 20 per cent waste at present remaining in the residue. He concluded that stibnite dissolves easily in NaOH or Na_2S from which antimony in a high state of purity is precipitated with a current efficiency of about 76 per cent, a voltage of 2.7, giving a power cost about equal to that of the electrolytic production of zinc. The solution must be regenerated or renewed when one pound of antimony has been produced per pound of NaOH used. The electrolyte may be reduced to Na_2S but the practicability of this has not been tried.

Mr. R. A. Wood's paper on "Brass Rolling Mill Alloys" emphasized the necessity of using the purest copper and zinc, of making sure that the alloy is kept pure, and of the extreme care necessary in annealing. The paper gives a most valuable list of analyses of the various trade-named metals.

American Foundrymen's Association

Twenty-second Meeting

The American Foundrymen's Association held a very successful meeting in Paul Revere Hall, Boston, during the week of Sept. 24. In connection with their technical sessions, a very interesting and instructive exhibit of foundry appliances was held in Mechanics' Hall. While there was considerable disappointment evinced at the decision of the Government that it could not spare the time of a trained officer to collect an exhibit of munitions with which the American foundrymen could become acquainted, yet the exposition, with its 160 odd exhibitors showed a considerable increase in number and volume over the last, held in Cleveland in 1916. The visitor is struck with the number of exhibits devoted to the finishing department—sand blasting and grinding equipment especially. Labor saving equipment of all sorts were much in evidence; man saving safety-first applications were also prominent. As an earnest of the sure trend in foundry evolution appeared several exhibits of chemical and metallurgical- and mechanical-testing materials.

JOINT MEETING WITH INSTITUTE OF METALS

On the first day of the convention was held a joint meeting with the American Institute of Metals, when the usual welcomining addresses, and those of **J. P. Pero** and **Jesse L. Jones**, presidents of the societies, were delivered. The report of the Board of Directors mentioned the fact that they offered in the spring to pay the expenses of a committee of their members to the allied countries to study their methods of producing castings for shrapnel and other munitions. The ordnance experts of the United States Government, however, did not think it probable that cast-iron could be used advantageously in the manufacture of shrapnel, and if they had been used, it had been from necessity rather than choice. It was therefore not practicable to arrange for an official visit to Europe for that purpose.

A. O. Backert, secretary-treasurer, reported that the total membership had increased to 1017, but that the decline in the number of associates had steadily declined ever since the Associated Foundry Foremen were merged. **C. W. Johnson** of the Westinghouse organization also read an interesting article on "Fire Prevention in Large Industrial Establishments."

GENERAL SESSION

On the second day of the meeting, **W. J. Kibby** read an interesting paper on "How Character Analysis Solves the Man Problem," pointing out the economy of placing a man in the right place by studying his physical fitness and mental equipment. He presented some of the fundamentals of such character studies. The Committee on Industrial Education reported that in considering the question of training of molder's apprentices, it had concluded that it would be well to establish experimental classes of actual apprentices, and the director of vocational work in the Chicago schools had promised to conduct such a course.

MALLEABLE IRON SESSION

A very interesting session on Malleable Iron was held on the fourth day. Among others, **A. D. Pratt** of the Babcock and Wilcox Co., discussed "The Theory of the Modern Waste Heat Boiler and the Possible Application to Malleable Furnaces." The theory of such installations has already been covered in METALLURGICAL AND CHEMICAL ENGINEERING (Vol. 15, p 696, e.s.). Mr. Pratt said that on the basis of experience in other fields, it is possible to compute the performances of a modern waste heat boiler from the records of coal burned, and exit gas temperature and analysis. A 15-ton furnace at the McCormick works of the International Harvester Co. had a 400 hp. vertical water-tube boiler installation representative of early practice. The performance of the furnace is plotted in curves showing a wide range at different portions of the melting cycle—and might be increased by 16.5 per cent with smaller heating surface in a modern design.

Mr. Joseph B. Deisher of the T. H. Symington Co., discussing "Carbon Losses in Malleable Iron Annealing," deals with many of the factors entering into the annealing of malleable castings in muffle and pot ovens. The safe annealing temperatures are from 1450 to 1650 degrees Fahr. for pot ovens and from 1500 to 1700 degrees for muffle ovens. Mr. Deisher believes that the 60 hours usually considered necessary to completely dissolve the iron carbide are not actually required and that the best practice is to bring the castings to the highest temperature at the beginning of the anneal, such temperature to be held until the iron carbide is dissolved, and then drop to 1400 degrees, which is considered favorable for the precipitation of the graphitic carbon. In a comprehensive discussion of the advantages and disadvantages of the pot and muffle ovens, the author concludes that the conversion rather than the removal of carbon in the anneal produces ductility.

Joseph Harrington and **W. R. Bean** both read interesting papers on the application of pulverized fuel to the melting of malleable cast iron. In spite of its manifest advantages, however, malleable foundrymen are reluctant to take up powdered coal in earnest. "It is certainly a case where precedent is wrong," the author concludes, "and the reluctance of foundrymen to take the first step will probably be balanced by their eagerness to fall in line just as soon as the pioneer has completed his installation."

GRAY IRON SESSIONS

In sessions devoted to gray iron castings, **T. Mauland** of the International Harvester Co. discussed "High Sulphur in Soft Gray Iron," in which he said that in spite of the fact that high sulphur is almost universally considered detrimental to good results in the foundry, he has observed that castings up to 0.12 per cent will sometimes be good, strong and soft. At other times with the other elements the same, the castings will be hard with sulphur less than 0.09 per cent. It may be inferred, therefore, that sulphur is not the determining element in the hardness of gray-iron castings. He concludes that sulphur in itself is not nearly so bad as it has been painted, and believes the reason good castings sometimes are obtained with high sulphur iron lies in the fact that the oxygen in such cases usually is low. **L. M. Sherwin,** Brown and Sharpe Mfg. Co., read a paper on "The Seasoning of Gray Iron Castings." After describing microscopical tests on a series of annealed bars he states that many important questions regarding this matter have not yet been satisfactorily answered and further experimentation is essential for their elucidation. **Edgar A. Custer** in discussing "Cast-Iron Shells in Permament Molds," pointed out the superior effectiveness of the cast-iron shell in attacking earthworks, that the efficiency of a shell fired against troops is dependent almost entirely upon the character of its fragmentation, in which particular cast-iron shells have been shown to be much more satisfactory than forged-steel projectiles. Cast-iron shells, with proper foundry procedure, also can be easily made in enormous quantities. France is making over 1,000,000 rounds a day at present in dry-sand molds. A steel forging for a 4.7-inch shell costs over $7; a cast-iron shell of similar size can be made for a little over $2. With these advantages in mind, the case for the cast-iron shell seems complete, provided proper foundry practice can be secured so the shells will be of uniform and satisfactory quality. To achieve this result, the permanent mold is recommended, and the details of making such shells were discussed.

STEEL CASTINGS

In the sessions devoted to steel castings, Major **C. M. Wesson,** Watertown arsenal, presented an important paper on "Steel Castings for Ordnance Construction," which we hope to publish in full in a future issue. A paper on "A New Method of Burning Crude Oil" was read by **W. A. Janssen,** Canadian Steel Foundries. After a brief resume of the early development of crude-oil burning apparatus, Mr. Janssen described a new system in which the air is preheated and subsequently mixed with the oil in definite proportions, creating a combustible gas. The gaseous product is forced into the furnace under pressure. The preheater is cast iron, and is provided with flues for the passage of the waste gases which form the source of heat. The vaporizer is a hollow cast-iron fitting provided with baffles to insure an intimate mixture of oil and air, and the thorough vaporization of the former. With this type of burner, Mr. Janssen stated, that oil economies of 40 per cent had been realized.

The great interest in electric melting furnaces was shown by a symposium of four papers on this matter by **John A. Crowley, Douglas Walker, C. R. Messinger** and **E. L. Crosby.**

Boston Meeting of American Chemical Society

In the report of the first two days' meetings of the American Chemical Society in Boston, given in our last issue the opening address of Dr. R. C. Maclaurin, president of the Massachusetts Institute of Technology was accidentally omitted. Dr. Maclaurin in welcoming the society to the Massachusetts Institute of Technology said that the man in the street may not pay much attention to the proceedings of the society, but none the less it is probably true that no body of men similarly associated is capable of contributing so much as chemists to the solutions of the great problems that the war presents. He said:

"I need hardly refer to the possibilities, nay, the actual achievements, in the operations of the war. Much is being done by the members of your society, the best of it quickly and without being heralded in the press, so that it will probably not be till the war is over that the public learns of the actual accomplishments of American chemists in the field that I have indicated. When the story is told it will add lustre to the name of American science.

"Every patriotic citizen to-day, whatever his calling, should be preaching and practising the doctrine of economy—the absolute necessity for avoiding all needless expenditure, which is only another word for work.

"This must be done everywhere, in our households, in our business, in our Government, and few can render so much service in saving work as the chemist."

The report of the war conference on Tuesday, Sept. 11, was given in our last issue, excepting the address of Dr. M. T. Bogert, Chairman of the Chemistry Committee of the National Research Council. A full abstract of Dr. Bogert's address follows:

Work of the Chemistry Committee of the National Research Council

BY DR. M. T. BOGERT, CHAIRMAN

American chemistry must justify itself, and show its ability to cope with the chemistry of other warring nations. What we have done to secure chemistry in this country may be illustrated by citing three organizations which we have at the present time, who are cooperating very effectively.

1. The Naval Consulting Board organized by the Secretary of the Navy, and concerning itself with problems which affect the Navy.

2. The work of the Committee on Chemicals of the National Defense Council described by Dr. Nichols.*

3. The third chemical committee is the National Research Council. This council was called into being before the outbreak of the war at the request of the President of the United States, and was organized by the National Academy of Science. It is the official adviser of the Government. It was very fortunate that this was done, because at the outbreak of the war we already had the necessary machinery to undertake the numerous problems which came to us.

The first business of the chemistry committee was the appointment of the necessary subcommittees.

In the second place, the census of chemists conducted by Dr. Parsons and the Bureau of Mines carried, as you are aware, a slip for research chemists—those who were interested in research. These research slips were all detached at the Bureau of Mines and transferred to our office, where they in turn have all been closely read, indexed and cross-indexed, and through the chairman of the sub-committee, we have now gotten out an alphabetical list of the chemists who are interested, and experienced in particular lines. That alone is a tremendous thing, because it puts in the hands of the sub-committees a list of the names of the men in the country who are interested and eager to attack problems which at the present time are unsolved. Further, this chemistry committee has co-operated in placing drafted chemists in service where they will be of benefit to the country. They have had to study 300 different problems and report through different departments of the Government concerning these different problems. Perhaps the chief function of the chemistry committee is that of endeavoring to act as a central clearing house. If that can be realized, it will be a splendid accomplishment for the country as a whole. If we have one centralized agency of this kind doing not only Government but other research work, some of the developments and overlappings that we have allowed, may be avoided. In connection with that function, a Bureau of Information could be established. Every day we have a great many questions of all kinds to answer, which can be answered by accumulated information.

We do not feel at all discouraged that all the suggestions which come in from the outside are not all of great value. The experience in France and England has been that one in 300,000 of the suggestions sent in, have some real value. Another function of the committee is that of raising funds to carry on its work, and I might add that one who has made this work possible is one that is benefactor of this institution also, Charles Hayden, of Hayden, Stone & Co., and he has been very generous in carrying out this work.

Another direction in which useful service is rendered is that of bringing distinguished chemists from France.

We have sent over to France and to England representative scientists who have studied the situation there at the front in the warring countries, and have brought back first hand information in order that we may direct our lines of work, and have the benefit of what was being done, and this has been of the greatest value on this side. Three other chemists are about to leave this country on similar missions, and we hope in this way to keep in close personal touch with what is going on on the other side. As a result of our experience at the present time, we believe that chemists are needed for the following:

1. Teaching is fundamental. We must have chemists to continue the teaching and training of new chemists—a recruiting station for chemists.

2. Chemists are needed for the control and direction of industrial operations of all countries—munitions, poison gases, gas masks, metal, leather, oil, alloys, drug, food and dye stuffs.

3. Inspection and analysis of munitions, supplies of all kinds, etc. This is a direction in which engineering and analytical laboratories of our educational and research laboratories throughout the country can help and are already helping, and will be called upon for

*See our last issue.

services to supplement agencies of the Government now had for that purpose.

4. Development of new plans and processes made necessary either by increased demand or by the cutting off of former sources—the potash industry, for example, and an example of a wholly new industry is that of poison gases.

5. Small scale manufacturing operations, in our educational research institutions, synthetic drugs and special reagents without which no research work can go on, and which are produced in such small amounts that they are of practically no interest to the manufacturer. This is very important for the carrying on of the war, and for the safety of the country. In this direction the universities and research laboratories are aiding, and will aid us.

6. For research, and to aid the Government in securing defense for our country, and to protect our soldiers, and also increase our power.

7. As advisers to the Government, bringing to it in the first place, the best knowledge and best qualified men of the country to attack problems and then initiate what research work is called for. We should not fall into the habit of assuming that because we cannot answer a research problem at once, therefore we should say that we are not interested in it. The warring nations will tell you that if they had only initiated certain research work at the outset of the war, the answer to some of the problems might be available, and would be determining factors, so we should initiate research work, although it may be some little time before the answer can be obtained. Another important function of our sub-committees is acting as advisers to the Government, and assisting them, and they are being of the greatest service.

8. For our Government laboratories to supplement the present forces when necessary on account of the demand put upon them, or to fill the places made vacant by men drafted into the army and into industries.

These are some of the directions in which chemists are urgently needed. As far as the needs are concerned, the first thing for the proper conduct of the work is the matter of funds. There must be an adequate appropriation in order that the work may be carried on, as without funds they cannot carry forward the work.

A better recognition is needed on the part of the Government of what this organization can accomplish. The Government should get into the habit of turning to this corps of chemists through the Committee on Chemicals of the National Defense Council, and the Chemistry Committee of the National Research Council for aid, which both are ready and prepared to supply.

Another need of the situation has to do with our industrial chemists and those who are drafted and exempted. I believe it would help the situation very much if the chemists drafted and then exempted were given some insignia to indicate that fact that they were exempted on account of their need in the industry, and that in that industrial army they would render just as valuable and important service to the country as if they were serving in the trenches. In France they wear an insignia on their arm, and something like that would help here. France also has an organization of industrial workers, and their work must be done very carefully. If they make any mistake, the first thing that happens to them is that they are sent to the front. On the other hand, if they are guilty of treason, they are tried before court martial and shot.

As far as the problems are concerned which confront this committee, let me say at the outset that we have a great many more volunteers than we have problems, and that you must not be disappointed if in spite of your willingness, you have been unable as yet to secure a satisfactory reply from the Chemistry Committee. Do not overlook the fact that the Government has already an existing agency for the study of a great many of these problems. We are not in any way trying to supersede them, but we are trying to supplement their work in every way that we can, and the reason why it has not been possible to transmit problems, is that there are more volunteers than problems. This condition will rapidly disappear.

An incident showing our co-operation with Government agencies and the character of some of these problems I will endeavor to indicate by one or two examples. As you will understand, many of the most interesting of these problems are of a highly confidential character, and cannot be stated.

In the first place, take such a problem as hydrogen. The question of hydrogen generation is a matter of considerable interest to our aviators. They must have the best possible method of producing an adequate supply of real hydrogen, and it is necessary also to have an outfit which can be used for this, and also on shipboard. That is a problem which involves the standardization of materials which are to be used for hydrogen. It involves also incidentally the question of ability to protect the hydrogen. An important problem in the submarine situation is the detection of hydrogen. It was necessary to devise an automatic detector. Co-operation with the Bureau of Standards and the Department of Chemistry of the University of California has resulted in the production of two detectors which are entirely satisfactory. This has been brought about by Dr. Bray and Dr. Lewis formerly of Massachusetts Institute of Technology and now at the University of California.

The submarine question has brought out a number of problems, such as the production of suitable non-corrosive metals or alloys for submarine guns and torpedoes, and equipment to be used on submarines. In the case of balloons, other questions which have come up relate to the fabric to be used. In the case of airplanes, the fabric to be used, and also the proper kind of "dope" to be used on the wings, and there is also the question of the right kind of glue to be used in the manufacture of propeller blades, etc. In airplane service, one of the most important questions is the question of a suitable fuel. This is of the utmost importance. If we are going to build an enormous fleet, we must see that they are provided with the best possible fuel, in order that the airplane may rise to a sufficient height to make an attack upon the opponent. This is very important. If an airplane is provided with a fuel which will not permit it to rise to the same height as its opponent, it is a distinct disadvantage.

In connection with the needs of our war, proper paints for our war vessels have been studied by various committees, and at the present time they are working in conjunction with the Bureau of Standards on

specifications for twenty-five different types of paint and varnish.

The fertilizer situation is being attacked from a number of points. The potash and nitrate situation and other problems have been studied by Dr. Wheeler, and it has been found that such a question as top dressing on winter wheat in spring means a difference of 200,000,000 bushels in the supply.

Such questions as the production of the necessary textile and dyestuffs have also been studied.

The question of synthetic drugs is also very important, and is now being studied. A large proportion of these drugs was derived from Germany, and it has been necessary for us to prepare these ourselves or go without them, and that means not only the question of patent situation which we are called upon to handle, but means the question of working out the details necessary for the successful manufacture.

The question of explosives in all aspects is now being studied by Dr. Comey, chief chemist of the Du Pont Co., not only in regard to adequacy of supply, of raw materials, but also the possibility of using other explosives, in order that we may be prepared in every sense.

The most important of all the fields in which we have been working is that of gas. At the time of the first gas attack, which was April 15, 1915, a chlorine gas attack was made. The result of that attack was such that the British General sent back word that if some protection was not provided in comparatively few days, they would have to give up that entire section of the line. If there had been no chemists, it would have been a very serious situation. This also illustrates the necessity of speed to which they were put. Inside of four days 3,000,000 masks were provided for the British Army. At the present time we have a great variety of gas protections. Some of the most poisonous gases are now being used at the front.

Presidential Address

Dr. Julius Stieglitz, of the University of Chicago, presented his presidential address on Wednesday evening, Sept. 12, in Huntington Hall in the old Rogers Building of the Massachusetts Institute of Technology in Boston. He said that chemistry is all that, thus far, has saved Germany from defeat. After Joffre on the Marne had killed her hopes for a swift, crushing victory through the violation of Belgium, it taught her that she must face a long struggle, in which, cut off from the world's supplies, she must make shift with what her own territories could yield and her chemists could produce.

"In the wonderful organization of power in France and England in the midst of war the French and English chemists have stepped in and brought their supplies of munitions of every variety, of remedies, of their own weapons of defense and offensive poison gas and liquid fire warfare, up to the need of meeting now on more than equal terms an enemy prepared years in advance.

"And in our country too, chemists have stood the ordeal of an unprecedented time. I have in mind our splendid achievement of having solved in these three years of warfare such tremendous problems which three years have brought to us as were involved in the speeding up of the production of thousands of tons of fundamental chemical products needed by our allies and now for our own purposes, steel and iron alloys of every variety of toughness, hardness and elasticity, purified copper by the millions of pounds, aluminium for airships and motor cars, abrasives on which the trueness of every great and every small gun depends, sulphuric acid and alcohol for the preparation of explosives, foods, oils and scores of essential products prepared on a scale never before seen."

Professor Stieglitz mentioned the growth of the society from somewhat over 8000 members before the war to nearly 10,500.

He also said: "It has been publicly encouraged in Germany—I am quoting from an excellent article by our friend, Dr. Baekeland—that German dye manufacturers after the war should allow only a limited and conditional quantity of dyes to go to foreign countries, including the United States, in order to give her home industries a great lead in recovering the commerce of the world in textiles.

"Even if this suggestion should not be put in effect, for Germany has more to lose than to gain by a policy of trade war after the reestablishment of peace, we may be sure that her own manufacturers will get the best of her supplies and every possible advantage. Our textile manufacturers and many other branches of industry will be at the mercy of competitors, assisted by Government direction, unless we have a declaration of chemical independence in this country."

He said that manufacturers should treat research chemists more fairly by sharing more equitably the profits resulting from their discoveries instead of exploiting them. The wiser policy has been largely responsible for the German leadership in chemical manufacturing.

He advocated a definite national policy looking toward the establishment of independence of chemical supplies. One of the most important measures necessary to this end he believed to be the fixing of protective duties.

"Much more than a question of coloring materials is concerned in a conscious policy to have our dye industries established on a permanent basis. It has often been emphasized that the manufacture of dyes is so closely related to the preparation of explosives that a flourishing dye industry in times of peace means ample facilities for explosives in times of war.

"No American would care to contemplate what our condition would be in the matter of large-scale production of explosives if we had become engaged in a struggle with a first-class power without the benefit, without the great expansion in our dye and explosive factories, which our commerce with England and France brought about after 1914. When peace comes, let no American forget this lesson. One way of insuring ourselves against a lack of facilities for a sudden expansion in the production of explosives is to keep capital invested in dye factories."

He spoke of the progress of United States universities and colleges in chemistry and urged that they "be kept not only prolific as to the output of men—the vast expansion in laboratories and attendance bear witness to quantity being insured—but that they also be maintained on such a high level of scientific quality that the product going forth will consist of the very best type of men."

Metallurgical Symposium

The metallurgical symposium held Thursday morning was the third held by the Society. Prof. W. A. Whitaker, of the University of Kansas, presided. The question was brought up as to the advisability of establishing a metallurgical division of the American Chemical Society to take up the chemical problems of metallurgy. Several of the members expressed their views on the subject, and it seemed to be the consensus of opinion that the society ought to do all in its power to foster metallurgical chemistry, that is, the theoretical side of metallurgy as distinguished from the purely practical side of metallurgy. No recommendations were adopted but the question will probably be taken up by the Council at a later date.

An interesting paper on "Stellite as a Substitute for Platinum" was read by Elwood Haynes, of the Haynes Stellite Co., Kokomo, Ind. The product is well known but its use as a substitute for platinum is quite an innovation. Mr. Haynes said it could be used in jewelry and was a very good substitute. It is limited as a platinum substitute for chemical purposes on account of its being corroded by several acids (not by nitric). It has about the same melting point as platinum. In order to show the wide range of its usefulness, Mr. Haynes passed around some spoons, knives, a razor, hatchet and several other samples which appeared to be indeed very good-looking articles. It is hoped to publish Mr. Haynes' paper in a later issue.

A paper on "The Effect of Annealing on the Electrical Resistance of Hardened Carbon Steels," by I. P. Parkhurst, was read by H. E. Howe. The general conclusions drawn by Mr. Parkhurst from his experimental work was that the total change of resistance increases with the carbon content.

Dr. J. W. Richards had prepared a very interesting paper on "Physico-Chemical Data Needed by Metallurgists." Dr. Richards was unable to be present and his paper was read by H. E. Howe. The paper discussed very fully the woefully insufficient thermochemical data available for metallurgists. This is true of both low and high temperatures. High temperature data are, however, even scarcer than low temperature data. He outlined a few subjects in which data were badly needed, mentioning the combinations of metallic oxides with silica, sulphur and with each other; the heats of formation of arsenides, arsenates, borates, manganates, aluminates, etc., and a large number of others. There is enough data needed to keep a dozen thermochemical laboratories busy for ten years. For temperatures above the ordinary our thermochemical data are not exact. For instance, in distilling zinc, the energy involved is far different than indicated by the equation $ZnO + C = Zn + CO$ when the figures for solid zinc are used as in this case zinc vapor is formed. Other data badly needed are the specific heats of all substances, the latent heat of fusion, latent heat of vaporization, specific heat in the gaseous state and liquid state. The latent heat of fusion is needed on steel, brass and bronze, and the latent heat of vaporization has been experimentally determined for only 3 metals and 6 metallic compounds. Vapor tension curves are badly needed. We only know the specific heat of brass and bronze from 100 deg. to 0 deg. The metallurgists are looking to the physical chemists for these data and laboratories should look into this field.

A paper on "Sulphur Dioxide in Metallurgy," by E. R. Weidlein of Mellon Institute, Pittsburgh, Pa., was read by G. C. Stone. The paper described work in an experimental plant at Thompson, Nevada, on the precipitation of leached copper by sulphur dioxide. The process is described in U. S. Patent 1,201,899, Oct. 17, 1916, which was abstracted very fully in our issue of Feb. 15, 1917, page 227. The process is applicable to low-grade sulphide and oxidized copper ores. The precipitated copper contains only oxygen as an impurity and runs over 99 per cent pure. An important feature is that the precipitation is continuous. Mr. George D. Van Arsdale of Phelps, Dodge & Co., said he would be interested to know the costs of working the process and was also interested in knowing that the precipitation had been made continuous.

A paper on "The Importance of Flotation in Copper Metallurgy," by E. P. Mathewson of the British-America Nickel Company, of Canada, was read by Dr. Dorsey A. Lyon of the U. S. Bureau of Mines. The paper reviewed the important developments during the last few years.

The "Theory of Froth" was discussed by Dr. W. D. Bancroft in his usual interesting manner. He said that froth may be defined as a mass of globules with liquid walls. In order to get a froth a surface film must be produced different from that of the body of the liquid. This involves a change in the surface tension, either greater or less, of the film from the mass of the liquid. If something can be put in which gives a more viscous film the froth will be more stable. Permanency of foam is a question of viscosity. If you fill up the film with a solid the froth will be more viscous, you can stabilize kerosene, pine oil, etc., with white lead.

Most oil mixtures used in flotation do not give stiff froths by themselves but the metallic sulphides make the froth permanent.

Dr. Charles H. Herty in the discussion asked whether oleo resin added to pine oil would help. Dr. Bancroft said that if it did not cut down the stiffening of the froth by the sulphides, it would be all right. Mr. O. C. Ralston of the Salt Lake City Station of the Bureau of Mines said that the important question was how to get selective action in certain sulphides, *i.e.*, how to make one mineral go into the froth and keep others out.

"Chemicals Used in Ore Flotation," was the subject of a paper by O. C. Ralston and L. D. Yundt. The paper was read by Mr. Ralston. It will be published in full in a later issue.

A paper on the "Action of Cadmium Salts on Lead and Zinc Sulphides," by M. H. Thornberry, was not read, as Mr. Thornberry was not present. Professor Whitaker said the substance of the paper was that cadmium salts greatly hindered the flotation of lead sulphide.

A paper on "Flotation of Zinc Sulphide Tailings," by W. A. Whitaker, S. F. Farley, and H. P. Evans, was read by Professor Whitaker. It is hoped to publish this in full in a later issue. Professor Whitaker said from the results of many tests they found that light oils such as pine gave high grade concentrates but a lower extraction than heavier oils. The heavier oils, however, gave lower grade concentrates. By properly mixing the light and heavy oils the best economical procedure could be obtained.

Third National Exposition of Chemical Industries

Comprehensive Report of Important Addresses and Meetings of Technical Societies*

Showing a continuous growth at the rate of 100 per cent for each year of its existence, the National Exposition of Chemical Industries was held for the third time in Grand Central Palace, New York, from Sept. 24 to 30, inclusive. With exhibits well in place at the opening hour, the management and exhibitors were fully prepared for the large attendance which marked the opening of the doors.

The opening exercises at 2 o'clock in the afternoon were marked by keynote addresses from the chairman of the Exposition Advisory Committee, and the presidents of the three great chemical associations of the United States—American Chemical Society, American Electrochemical Society and American Institute of Chemical Engineers. These addresses, short and to the point, are given in full below. Accompanying is a view of the distinguished speakers and managers of the exposition who occupied the platform at the opening session, Mr. Charles F. Roth, presiding.

A feature of the exposition which appealed strongly to the popular mind and held interest also for technical and engineering visitors, was the exhibition of moving pictures illustrating power development and the operations in a variety of industries.

These pictures had an educational value of high order and served to stimulate general interest in chemical industry in the United States.

*See page 420 for descriptions of exhibits.

The Battle of the American Chemical Industries

By Chas. H. Herty†

The battle for national self-containedness in that portion of the line held by the American chemist is progressing favorably. It is not yet won, but many heights have been conquered, many formidable streams crossed, and the open plains of full national service are almost in sight.

This exposition, increasing in magnitude each year by 100 per cent of its original size, constitutes the bulletin by which the nation is informed of the progress made.

SPEAKERS AT THE OPENING SESSION

Left to right: G. W. Thompson, Pres. American Institute of Chemical Engineers; Julius Stieglitz, Pres. American Chemical Society; Messrs. F. W. Payne and C. F. Roth, managers of the Exposition; Colin G. Fink, Pres. American Electrochemical Society; Charles H. Herty, Chairman Exposition Advisory Board.

In the center, the advance up the steep slopes of "capitalization" has been marked. In 1915 there was added to the chemical industries $65,565,000; in 1916, $99,244,000; and in 1917, up to Sept. 1, $65,861,000, a total gain of $230,670,000.

On the extreme right the forces of "Empiricism" have steadily yielded ground to the advances of our research chemists. More and more called upon for utmost effort, they have never failed to respond.

On the left flank a steadily increasing force of the ablest American chemists is being gathered to capture the hill of "Obsoletism of Army Equipment," and is providing the great armies we are now raising with

†Chairman, Advisory Board of the Chemical Exposition.

the most efficient forms of modern chemical means for both offensive and defensive warfare.

On the right center the terrain of "Congressional Apathy" has been partly won, as typified by favorable protective legislation for our dyestuff industry and by the guarding of the all-important electro-chemical industries at Niagara Falls from power shortage due to lapsing legislation.

On the left center the quagmire plains of "Public Indifference" have been largely dried and made passable through the clearing skies of a sympathetic daily press, which has constantly emphasized the value to the independence of the nation of a full-rounded chemical industry.

Finally, the counter attacks of subtle propaganda against the ability of American chemists and the worthiness of our products, such as American dyestuffs, have ingloriously failed.

The optimism engendered by such splendid progress will prove, however, a curse indeed if it leads us to overlook two features of the present situation.

In the first place, in order to man the present lines of this battle of the chemical industries we have already drawn heavily upon our reserves in the universities throughout the country. Many professors, advanced students, and even only partly trained students, have been called into the industries. This, together with the losses by enlistment, has created a serious shortage of chemists, whose replacement through all favoring means should be a constant charge upon the liberality of the leaders of our chemical industry and the farsightedness of those vested with the powers of national administration.

In the second place, this army has its camp followers, men who, under the guise of chemistry, seek to enlist capital in developments bearing all the earmarks of get-rich-quick schemes, the disastrous outworking of which may perhaps shake that confidence between capital and chemists which should grow daily stronger if this battle is to be fully won. And it must be won. Only patriotic motives underlie that conviction.

It is the nation's service to which we are called, and to that service the good faith and untiring zeal of the American chemist is pledged.

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American Chemical Industry and the American Chemical Society

By Julius Stieglitz*

"Every cloud has its silver lining," and even the great black cloud of war which has been oppressing the world these three years has been penetrated here and there by bright rays of good accomplished. One of these brighter effects of the disaster, as far as this country is concerned, has been the influence of the war on our chemical industries. Facing the necessity not only of very greatly expanding their output, but also of developing many new products and of making older products of a far higher grade in quality than ever before, our American industries, as evidenced by the three expositions held in this place, have met and conquered one great problem after the other. We may confidently expect, and indeed we must insist, that out of this period of forced effort we shall emerge independent of all foreign nations in regard to our ability to supply the basic chemical needs of our country, not only in quantity but also in quality. As a single instance of the progress these years have witnessed in a field we must continue to hold after the war, let me recall the dismay of our universities—and I am sure also of our industrial laboratories—when, early in 1915, we saw the supplies of Jena glass and of other finer glass cut off. Yet to-day we are manufacturing in the United States glassware fully as good as, if not indeed superior to, the German brands we thought we never could do without. When the war is over, no matter how fierce trade competition may be, we must see to it that our new industries survive, that we do not relapse into our old dependence on European sources for almost every article in which quality, highest quality, is essential! In the heat of effort of these years only the most urgent and immediate of our needs have been met; some of these results still depend for their stability upon war conditions, they are still too liable to collapse when the world returns to its normal life and trade is free once more. In this situation, fraught with magnificent possibilities for much greater chemical achievements, but also with great dangers for the permanency of some of the American chemical industries, the American Chemical Society, for which I am speaking, sees its opportunity of being of new and still greater service to the country. Including in its membership of more than 10,000 the great majority of leading technical chemists, as well as practically all the foremost men of the chemistry staffs of our universities and colleges, the society is in a position to render service in any branch of chemistry, service that will be expert and at the same time judicial and unbiased in its spirit. Thus the society, influenced by the conviction that our national welfare demands independence in dye manufacturing, was active in aiding the movement to secure a much needed measure of protection by duties on dyes. They, at the invitation of the chairman of the United States Tariff Commission, the American Chemical Society, through its advisory committee, a few months ago, recommended the name of an expert on chemical schedules, Dr. Grinnell Jones, who is now working with the commission on the task of placing the tariff on a scientific, non-political basis. The society recently urged upon the Secretary of Commerce that standard chemicals and reagents are as essential for successful work, for the saving of wasted effort, in chemical industries, as are standardized weights, measures and gages in other industries. With the approval of Secretary Redfield, the Bureau of Standards, and with the co-operation of a committee of the American Chemical Society, has now started this important work. Then our appeal in Kansas City to the women of the country to refrain from the purchase or acceptance of platinum jewelry had its immediate effect; within a few days thereafter the jewelers' representatives in conference with the Secretary of Commerce agreed not to use the precious metal for heavy articles, thus making a larger proportion of it available for the industries. According to the latest information that has come to me, the price of platinum has at last begun to recede somewhat, instead of continuing the steady rise which its extravagant use in jewelry brought about, and which put a burden equivalent to a duty of several hundred per cent on a vital necessity of our scientific and industrial laboratories. I have the fullest confidence that if the situ-

*President, American Chemical Society.

ation should remain intolerable we shall have the support of the government in taking much more stringent measures to protect chemical industries and scientific work, so vital to our nation's life, against a use that is, after all, a matter of a mere luxury. Further, at the instance of the American Chemical Society, and in co-operation with a committee of the society, the Bureau of Foreign and Domestic Commerce has started the compilation of as complete information as it can secure for the guidance of our industries in regard to the chemical needs of manufacturers, the sources of supply of crude and finished products, and the relation of the various products to one another and to specific industries. Thanks to the efforts of the able editor of our industrial journal, Dr. Herty, a large fund has been raised to make possible this co-operation of the society with the government in this important work, and if the chairman of our committee, Dr. B. C. Hesse, has his strenuous way the work will be a model of thoroughness and usefulness.

I have mentioned these instances of the activities of the American Chemical Society in order to emphasize that the society would cordially welcome any appeals made to it by industries needing support of one kind or another. We are now organized for quick and effective action in matters of legislation and policy through the President's Advisory Committee, in matters of research through our affiliation with the National Research Council, all of whose active members in chemical fields are also active members of our society. If such appeals or suggestions are received, they will receive prompt and earnest consideration, and, if necessary, they will be looked into by committees of experts, not only with that fair judicial spirit which science develops in its devotees, but also with that sympathy and consideration which the service of our country instils into her sons. Final action will then follow, with that fearlessness and energy which a good cause always warrants, and which we trust will always be truly in the interest of the American Chemical Industry.

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The Electrochemical Industries

By Colin G. Fink*

It was certainly a very propitious moment when, three years ago, Mr. Roth and Mr. Nagelvoort suggested and planned the first chemical exposition. The American Electrochemical Society heartily welcomed the idea, and felt fully confident that the enterprise would be popular and successful. An undertaking which is based on the promotion of the common welfare, an undertaking that affects the progress and prosperity not of a few individuals but of every member of the country; an undertaking that serves to teach and demonstrate in a very striking and lasting manner the diverse applications and activities of the most fundamental of all national industries—an undertaking of this kind *cannot* fail; it *must* succeed. At the first exposition the exhibits were confined to one floor; in the second year the booths extended over two floors; and in this third year practically every square inch is occupied. Very soon Mr. Payne will have to build a bigger palace.

Never before in the history of electrochemistry has the vast importance of the various electrochemical products been so forcibly brought to the attention of our government and of our people as in the present year of the great war. Take from this country its electrochemical industry, with its numerous and diversified manufactures, and the martial strength of our country is hopelessly crippled. Think of the hundreds of machine shops that are utterly dependent on the electrochemical abrasives, carborundum and alundum; think of the thousands of rifles and guns turned out every month with the aid of high-speed steel made from electric ferro-alloys; think of the millions of pounds of electrolytic copper that are absolutely essential for our electrical apparatus. There is the airplane, whose light, strong stays are made from the electrochemical metals, aluminum and magnesium; there is liquid chlorine, a product of the electrolytic cell, and the basis of the Carrel-Dakin method of treating the wounds of our heroes; there is electrolytic hydrogen, used in all of our scout and observation balloons, and there are the numberless electric alloys entering into the composition of nearly every item of the government's vast military equipment.

An interesting feature of the electrochemical industry is its American origin and its present international scope, international in so far as the industry is not restricted or confined to one or two countries or localities. Take, for example, the calcium carbide industry; this was founded by an American, Thomas Willson; within a brief generation it has grown, in leaps and bounds. To-day there are large carbide factories in almost every civilized country of the world. Compare with this the sulphur industry, confined to the United States and Italy; or the petroleum industry, confined to the United States and Russia. The natural saltpeter industry is confined to Chile, but the electrochemical saltpeter industry, founded by Bradley and Lovejoy at Niagara Falls, has spread to every important civilized center.

Wherever low-priced water power or low-priced fuel is available in generous and steady amounts, there electrochemical industries have been and will be established. Our country has been foremost in the electrochemical industry ever since its inception, due to American genius on the one hand and to our vast natural resources on the other. May we continue to lead the world in the supply of the many electrochemical products: pure metals and alloys for the arts, gases for cutting and welding, chlorine and peroxides for our hospitals, chlorates and acetone for munitions, nitrates for the farm and defense, abrasives, electrodes, solvents and lubricants. May we continue to excel in the products of the electric furnace and the electrolytic cell.

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The Work of the Chemical Engineer

By George W. Thompson*

This exposition demonstrates the greatness of the progress which chemical industry in all its branches has made in the United States in recent years. When an industry is small its requirements are small. As it becomes larger its requirements become larger. The manufacture of chemical products on a small scale in a laboratory is a relatively simple operation, but when this manufacture is conducted on a large scale, involving the investment of considerable capital, then the prob-

*President, American Electrochemical Society.

*President, American Institute of Chemical Engineers.

lem is much more complicated and much more difficult to solve.

On this large scale the chemical engineer is the important factor; not so much perhaps in the development of the processes as he is in the devising of machinery that will carry out these processes. Most chemical processes have been developed upon a small scale in the laboratory. All of the reactions have been worked out in this way. When the process has become so developed it is studied for the purpose of putting it into operation on a scale that will produce a relatively large quantity of chemical product. To do this, the knowledge of the mechanical engineer is needed, but in addition to the knowledge of the mechanical engineer there must be supplied a knowledge of the resistance of materials to chemical reaction, which is provided primarily by the chemical engineer. This is particularly well illustrated in this exposition, where apparatus for a great variety of uses in chemical manufacturing are displayed. In practically every chemical manufacturing operation a great part of the study leading up to its becoming a commercial success has been the finding of materials from which the apparatus could be made in which to conduct the chemical reactions involved.

On small-scale manufacture, platinum, glass and porcelain have, in most cases, been satisfactory. The use of these materials, however, for large-scale operations has been prohibited by the high cost of the materials or their fragility. It has been found, however, that by the selection of certain alloys of iron, chemical apparatus can be manufactured in which certain chemicals have been made to react upon each other without reacting upon the apparatus. Such reactions could be conducted in porcelain or stoneware were it not for the difficulty of making large porcelain or stoneware vessels that would not be destroyed by the heat of reaction, or necessary to reaction, involved in the process. The discovery that silica could be made into chemical ware, and that such ware had a very low coefficient of expansion, has made possible the use of such ware for many operations requiring the application of heat to liquids. With the demand made upon it, the manufacture of chemical stoneware of intricate shape and design has progressed to a remarkable degree, so that within the limits of its use there is practically nothing that can be asked for in this class of apparatus.

Our early knowledge of chemistry had to do almost exclusively with irreversible reactions. Modern chemistry has largely to do with the reversible reaction, a reaction which takes place according to fixed rule, as determined by the temperature and pressure under which and at which the chemical reaction takes place. Every chemical manufacturer desires to get as high a yield of product as possible from every chemical reaction employed. To do this he must, in many cases, control the temperature or the pressure, or both, as the case may be, within certain relatively narrow limits. The needs of chemical industries in this respect have been so great that accurate instruments for the measuring of temperature and pressure and for their automatic control have become imperative needs. At this exposition there are on exhibition numerous pieces of apparatus designed particularly for the purpose of controling temperature, and to some extent pressure.

Every chemical industry depends to a certain extent upon its operation being carried out economically. This economy must extend to all departments. One of the most important departments is that connected with the production of power. The importance of obtaining the highest efficiency possible from a steam boiler is self-evident, and this can only be done by having as complete as possible combustion of the fuel used. There is one sure way of doing this, and that is by having continuous readings made of the carbonic acid gas present in the stack gases. It would be too expensive to employ a chemist to frequently take samples of these gases and analyze them, but with modern CO_2 recording instruments this is done automatically, with great economy in steam production. Such apparatus has also been available in cases where the CO_2 is used in chemical processes. By a greater concentration of CO_2 the handling of excessive quantities of useless gases is avoided.

The designing of apparatus in which to conduct chemical reactions, with the result that desirable chemical compounds are produced, is also peculiarly the work of the chemical engineer. The reactions themselves, as indicated above, have become known as the result of laboratory work, but to design apparatus so that these reactions will go on with the greatest practicable rapidity, and to the highest degree of efficiency, requires a man peculiarly trained in some way to apply on a large scale the law of mass action and the other laws of physical chemistry. The removal of an undesirable component rapidly and efficiently, thereby taking away the slowing-up effect due to its partial pressure, is often a difficult problem; but with the modern methods illustrated in this exhibition the problem becomes easier. Here we find apparatus designed for particular purposes in which operations can be carried on in a vacuum, or with the assistance of efficient stirring appliances, or in the utilization of centrifugal force.

Much of our progress has been due to the utilization of electrical energy, and in this exposition are shown the products of the electrothermal reactions, also electrolitically prepared or refined metals and chemical products. Here also are seen illustrations of the removal of suspended matter from gases by terminals highly charged with static electricity, and means for separating minerals electrostatically or by the electromagnet.

These are only a few of the many illustrations which could be offered of what is seen in this exposition, showing the mechanical genius of the American manufacturer and his ability to convert chemical reactions into profitable business enterprises. I believe it would be proper to extol this ability. The American cannot expect to excel in everything, and if he excels in this particular line it is a sufficient "Crown of Glory." That the manufacturer of chemical products has not accomplished everything that could be desired has not been due to his lack of ability or energy, but has been due to his inability to obtain those raw materials which nature has furnished to other countries more generously than she has to us.

With the progress of chemical industry the kinds and varieties of chemical products made are increasing from day to day. We see evidences of improvement in quality and the probable reduction in price as the competitive conditions become more nearly normal.

The Institute of Chemical Engineers is glad to join in this exposition in an advisory capacity, or in any other way it can be useful, because it believes that the

future commercial success of our country depends upon the continuance of the present efforts, looking in the direction of the expansion of chemical production and the manufacture of chemical products.

Tuesday Meetings

On Tuesday afternoon Alexander Silverman of the University of Pittsburgh gave an illustrated lecture on "Glass Manufacture," and showed many forms of blown, molded and pressed glass.

On Tuesday evening a special session was held which was presided over by Dr. B. C. Hesse of the General Chemical Company. Dr. Hesse opened the meeting with a splendid address, which we publish here practically in full.

Introductory Address of Dr. B. C. Hesse

"The program of this evening is admirably adapted to illustrate and emphasize the relations that may and do exist between abstract scientific knowledge on the one hand and the realities of every-day life on the other. Not that abstract scientific chemical knowledge is alone so concerned, for there are many others that will occur to you and I need merely remind you of Faraday's electromagnetic theory of light of 1845 together with the purely mathematical investigations of Maxwell in 1864 on the one side, and of the Hertzian waves of 1888 and Marconi's wireless telegraph in 1896 on the other side.

"Some sixty years ago an English youth still in his 'teens, pursuing an abstract scientific problem, encountered an unexpected and astounding result and upon this he built an industry, which has since developed into gigantic proportions, but whose enormous influence and importance were not convincingly impressed upon the general public until the present world-war. I refer, of course, to the present-day coal for chemical industry in all its ramifications into every-day life all over the world. This, however, was by no means the only case in which the peoples of the world were rudely awakened. Of the many results of that awakening two will be discussed to-night.

"Suddenly, and even violently, confronted with the actual reality of our dependence, both direct and indirect, upon foreign countries for a great many things in common and widespread use, the general public became most insistent in its demand; first, to know why such a condition had been permitted to grow up, and second, to have that condition permanently abolished at the earliest moment.

"Analysis of the situation discloses that in the first of these two demands there were at least two general classes, the first class comprising those cases whose importance was recognized and for which all or substantially all needed raw and similar materials for domestic supplies, but whose utilization in such domestic manufactures was discouraged by domestic consumers of such manufactures, or by our Federal legislators, or by both combined; in the second class were those cases whose real and interlocking importance did not sufficiently impress themselves.

"A first approach to an answer to the public demand as to why this condition was permitted is as to how it grew up; it grew up through our own acts of omission, because as we built up our industries we did not, as a nation, seriously, systematically and persistently study what effect sudden deprivation of the non-domestic materials employed in these industries would have on our nation as a whole, and then act to prevent or minimize such effects; that applies to our citizens, to our Federal officials, and to our Federal legislators. Just why this condition existed is not easy of explanation, but, no doubt, a large contributing factor was the general disbelief in a war of present-day proportions and effects.

"If I am correct in my conclusion that this dependence grew out of this general disbelief in such a war then I am probably correct in deducing therefrom that the second public demand, permanently and immediately to abolish that dependence, is based upon a public belief in a possible recurrence of such a war and public determination not again to be so disadvantaged in such an event.

"In that view it becomes necessary constantly to determine what things not made in this country must be made here; then to determine the best way of making them; next to decide what measures, Federal or otherwise, are needed to make them permanent, and, finally, to carry out the necessary program.

"To help solve the first two sections of this program, namely, what to make and how, the National Research Council was created; to aid in solving a part of the third section of this program the United States Tariff Commission was created by act of Congress in September, 1916. For products of and for our chemical industry the Chemistry Committee of the National Research Council has taken over the burden, and the Tariff Commission has provided for expert chemical direction and execution in its technical staff. The National Research Council is largely a volunteer offering of our citizens; the Tariff Commission is the contribution of our Government. Since our citizens and our Government have so determinedly and so sagaciously joined forces we may confidently look forward to lasting results of untold value to our country; it is a sure way to make a democracy lastingly more efficient than an autocracy.

"While the immediate work of the National Research Council is necessarily directed towards helping to remove present defects in our means of national defense, yet it ultimately will be engaged in helping to determine the best course of development of the whole country and the best way to effect it. We may, therefore, expect that the influence of the National Research Council will ultimately penetrate and benefit every branch and division of our national activities. However, its work cannot last if the country does not continue to develop men and women who are capable of research work and, therefore, a collateral field of influence of the National Research Council will be to assist in keeping our technical schools, universities and colleges at the very forefront of educational efficiency. Finally, we may confidently expect that the National Research Council will be the very efficient 'eyes of the nation' by keeping close watch on all scientific and technical progress all over the world, discerning our own national advantages in developing selected portions for ourselves and in co-ordinating our efforts for such national development.

"Among the Federal measures that influence our domestic development is the treatment we accord foreign products at our ports—that is, our tariff policy. The primary purpose of a tariff levy is governmental

funds, and in normal times our customs receipts are almost one-half of the total ordinary receipts of the United States Government; a subordinate purpose is to foster and enlarge domestic industry by wise and farsighted adjustment of customs rates and at the same time not unfavorably to affect the cost of living. Heretofore, such industries as employ much labor have by preference been fostered by our customs policy, and in comparatively rare instances only has any other test of eligibility to tariff help been applied; the test of the measure of such protection has been from 'difference in cost of production plus a fair profit' upward to all the tariff would bear. In 1916 Congress created the third of our tariff commissions to help it solve the problem of customs rates fairly and equitably to all. At the same time Congress greatly increased the difficulty of that problem by enacting what it intended and expected to be a set of customs rates on materials and products of the coal-tar chemical industry of such dimensions as to make importation unprofitable and domestic production profitable. Such rates had heretofore been consistently refused by Congress for more than thirty years, because such an industry employed relatively little labor and its products were raw materials for so many domestic manufactures that not only would our cost of living be advanced, but our competitive ability curtailed by such duties. This tariff of 1916 says in effect that, since the work of 2,000,000 of our people can be interfered with because 7000 other people are not here making things indispensable to the 2,000,000, we must have that industry here even if it employs only 7000 people, or, in other words, 'key industry products' must be made in the United States. The problem that now confronts the Tariff Commission is to get together all the material and facts so that Congress can enact a tariff that will provide half our ordinary Government receipts, will not unfavorably affect the cost of living, will expand our domestic industry to its maximum and will prevent its being crippled because of failure of the usual channels of international trade.

"In order that the Tariff Commission may properly discharge its duties to Congress it is necessary for it to have comprehensive and complete detail information on a vast multitude of different subjects and items so arranged and so co-ordinated that it will lend itself to the treatment to which the commission must submit it before a report to Congress can be made. For the purpose of so collecting and collating information the commission has established a technical staff comprising specialists in the various technical branches involved. Among such specialists there is a chemist.

"In reading our tariff enactments, the all-pervasiveness of things chemical is very striking; but only recently has that impressed the general public and obtained recognition from Congress. The chemists' interests do not end with Schedule 'A,' which deals largely with chemicals and with so much of the free list as relates to things allied to those of Schedule 'A,' but they permeate almost each and every one of the fifteen schedules of the act. Obviously, the chemist member of the Technical Staff Commission must examine a host of industries not ordinarily looked upon as chemical in addition to the very large number of industries that are acknowledged to be chemical in greater or smaller degree. His task is most difficult, and its successful execution will require much farsighted, patient and diligent labor on his part and the frankest and fullest co-operation of our industries."

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Dr. M. T. BOGERT, Chairman of the Chemistry Committee of the National Research Council, then followed with an address on the work of the council. His address is not included here, as an address which Dr. Bogert gave on the same subject at the Boston meeting of the American Chemical Society will be found in the report of that meeting on page 384 of this issue.

Mr. WILLIAM S. CULBERTSON, member of the U. S. Tariff Commission, delivered an interesting and important address on "The Tariff Commission and Our Chemical Industries." The keynote of his address was an appeal for a greater co-operation between the chemists in the universities and industries and the Tariff Commission, which is investigating the chemical industries of the country in their relation to the tariff.

Mr. GRINNELL JONES, chemist to the Tariff Commission, in his address on the "Chemical Schedule," dealt chiefly with the developments of the listings of the schedule and showed wherein they could be improved. He mentioned the work of the American Chemical Society in trying to obtain better statistics. This work is going forward at the present time with the co-operation of the Government officials, and the results will be published later. Mr. Jones announced that the Tariff Commission was planning to publish regularly an Information Catalog giving many pertinent facts on the tariff situation. Publication of both Mr. Culbertson's and Mr. Jones's papers is reserved for a later issue.

Wednesday Meetings

On Wednesday afternoon lectures were delivered by M. A. WILLIAMSON of the Norton Company on "The Manufacture and Use of Alundum and Crystolon," and P. A. BOECK of the Celite Corporation on "Increasing Plant Production by Heat Insulation."

On Wednesday evening several very interesting addresses were presented. The address of Dr. L. H. Baekeland will be found below practically in full. We are very sorry that lack of space prevents our publishing the addresses of W. S. Kies, vice-president of the National City Bank, on South American trade, and by C. H. Boynton, president of the Russian-American Chamber of Commerce, on Russian trade.

The Future of Chemical Industry in the United States

BY DR. L. H. BAEKELAND

Member of the Naval Consulting Board of the United States.

Judging from the scarcity of aniline dyes at the beginning of the war, most people made the erroneous deduction that we had no chemical industry to speak of. This is a gross error. As far as the mineral chemical industries are concerned, this country, even before the war, could stand excellent comparison with Germany or any other country. In fact, when it comes to the production of acids and heavy chemicals, the United States, in several of these branches, was decidedly ahead of Germany. This is particularly the case in her important electrochemical industries, which were developed way ahead of those of any other country.

There is no doubt, however, that we were behind in the manufacture of synthetic organic chemicals, which include the coal-tar dyes. But there was nothing strange or abnormal in this situation. The importation of these products in the United States before the war did not exceed $10,000,000 a year, this covering more than 1000 different kinds of products, all of which require special processes of manufacture, and some having to be worked in very small units. The manufacture mainly requires not only good chemists, but also inexpensive skilled labor which it takes a long time to train. As a business proposition, there was little to attract shrewd American business men.

If Germany has specialized in this branch of chemical industry, it was merely because she did not have the same opportunities for enlisting in other fields of enterprise. Here in this country we had new mines to exploit, new fields to cultivate, new railroads to construct, and many more industries of immediate importance claimed the full attention of our men of enterprise or scientific training. No wonder, then, that a little paltry industry of this kind was neglected.

Nevertheless, as far back as the early seventies a few enthusiasts started the manufacture of aniline dyes in the United States. They were making quite some headway, but in 1883 they had to perish through unfavorable tariff legislation. At that time German agents were already at work in this country and were leading our textile manufacturers by the nose, and they helped them in their lobbying for the lowest tariff on dyestuffs, claiming that Germany would serve them, furnishing them with what they called their "raw material." This situation acted as a boomerang and paralyzed our textile industries at the beginning of the war.

Since then this country has realized that we must not estimate the value of the color industry in dollars and cents, but by the direct bearing it has as a key to all other industries. A few cents' worth of the right kind of dyes decides whether a hundred dollars' worth of textiles can be sold or not in the open market. What is most extraordinary, almost a wonder, and bears witness to the flexibility and adaptability of American enterprise, is that in less than three years we should have made ourselves independent of Germany in the line where she had the start on us since half a century.

This awakening of the chemical industry has carried us along also in other chemical lines. Attention has been given to problems which formerly were outside of our natural field of action. We have carried the mass-production of synthetic explosives to a point never dreamed of. With truth it can be said that if it were not for one of our largest chemical manufacturing companies, which promptly rushed to the rescue of the Allies at the beginning of the war and furnished them with explosives of which they were so short, the war might have been ended a year ago in favor of Germany. Since then the chemists of France and England have shown also abundantly what they can do if conditions require it, and everything points out that after this war is over the supremacy of Germany in some of the chemical industries in which she heretofore was a leader will be a thing of the past.

Future Permanence of American Chemical Industry

If anybody asks what have the chemists been doing, let them visit this Exposition and be convinced that our chemists have not been asleep. But you will ask: "Is all this going to last? Are not most of these industries simply war-babies, bound to vanish as soon as peace is declared and conditions again become normal?" Some of these industries undoubtedly will disappear as soon as the war is over, particularly some ill-conceived projects, badly managed and badly financed. Others will have to shift the bulk of their production to other articles; others again may have to reduce their capacity. Then almost all of them will have to be satisfied with smaller profits. The latter effect will not be so much of a detriment as some people may imagine. The apparently high profits of to-day are considerably offset by the uncertainty of obtaining the raw materials and other feverish conditions which make manufacturing more of a gamble than it ever was heretofore. Smaller but steadier profits are more conducive to the sound development of an industry.

As stated before, we already had made a splendid record even before the war in the development of our industries of heavy chemicals, in the mineral or inorganic line. The steady development of these industries will very probably proceed as in the past. Our greatest development will consist in the further extension of industries in the organic field. When the present crisis came, we had no trouble in finding chemists and chemical engineers in the field of acids and heavy chemicals. Our lack of experience was mostly evident in the newer problems of coal-tar dyes and other organic industries. Here, like in other fields of chemical industry, it is not enough to know a chemical reaction on a laboratory scale. It makes an enormous difference whether you are manufacturing by the ounce or by the ton. In a laboratory, operations can be performed in little glass vessels, or in porcelain or expensive platinum. On a manufacturing scale, all this becomes totally different and the difficulty is no longer the chemical reaction itself, but the vessels and the methods of carrying it out. Acids and other substances which attack iron and other metals have to be handled in machinery which can withstand their action and insure not only the highest yields but great purity, and exclude the possibility of accidents. An entirely new industry had to be created for this purpose—the industry of chemical machinery and chemical equipment. But this was not all; the best chemists and best engineers are powerless if they do not have carefully trained and experienced foremen and workmen. Labor in the chemical industries does not count so much by number as by quality and reliability. One careless act of one single workman can blow up a whole plant or stop manufacturing for several weeks. These have been the great impediments during the first months when we had to tackle entirely new industries. Now that we have familiarized ourselves with the conditions, and that we have every right to feel confident in our further efforts, there is every good reason and every good opportunity why we should turn our abilities to other lines of organic industry besides that of the coal-tar industry.

It is said, with right, that one of the reasons why we had no coal-tar industry in the United States was that there was no available coal-tar because our methods of making coke and gas were such as to exclude this raw material as a byproduct. Conditions have changed since then, and now we are abundant producers

of coal-tar, and the quantity of this raw material, from which so many chemicals are made, will undoubtedly keep on increasing for many years to come.

But there are other raw materials in the organic line which hitherto have not been utilized to the proper extent. For instance, our petroleum and natural gas have thus far been used for little else than as a fuel. It only requires research and enterprise to make it a raw material and a starting point of as many valuable products as coal-tar has supplied until now. The same can be said of our agricultural products. In fact, every agricultural product is a starting raw material from a chemical point of view. Starch, sugar or wood may be a starting point for alcohol, one of the most useful chemicals ever introduced to mankind, and for which the future industrial uses are almost limitless as soon as it can be manufactured and distributed at a sufficiently low price. Nevertheless, our chemical engineers have been thinking along inorganic or mineral lines. From now on they have learned to tackle problems in organic chemistry. If they succeed half so well in this new line as they have done in the old, there is very little doubt that this country, with its limitless resources of organic products, will find ample opportunity of building up new chemical industries for products hitherto of little use or scarcely known, but for which a market can be found as soon as they can be supplied at a sufficiently low price and as soon as we become aware of the new possible uses. It will be the story of so many chemical substances which at first found no market and of which sometime afterwards the demand exceeded the supply.

New Attitude Necessary Toward Chemical Industry

I mention this particularly because some short-sighted men are inclined to believe that the chemical industry will be restricted by the present market and by the world competition of other chemical-producing countries. There is no doubt that at first a strong commercial struggle between competing manufacturers will set in. This will be the critical period, and I fear that during this period this country will be at a disadvantage unless we change radically our present attitude. Those who framed the Sherman Law did not consider that if a certain amount of competition is good, too much competition may be killing for all competitors concerned. In reckless commercial competition, the healthy technical efficiency, which is the basis of every sound industry, is frequently overlooked. Several manufacturers in this country, underbidding each other and in the meantime leading to over-production, can hardly compete with those of other countries supported by a paternal government which encourages the formation of trusts or Kartels, and favorizes exportation by subsidies or bounties, as done frequently in the past. These remarks apply specially to Germany. We know that not only had she her political agents distributed in all foreign countries, but she maintained a staff of agents who were always on the watch to detect a weakness in our situation and who never missed an opportunity to mix in our attempts of tariff legislation. The influences which in 1883 killed our dyestuff industry are still at work to-day, when they surreptitiously introduce words of double meaning which jeopardize the intent and purpose of our latest tariff laws. To what extreme measures Germany is ready to go in order to maintain her supremacy in certain industries can easily be guessed by what we have learned of late. In her political machinations in all countries, some glimpses of her intentions can be gained, now and then, by incidents such as the following. On Feb. 1, 1916, in the *Faber-Zeitung* of Berlin appeared the following paragraphs:

> "The German coal-tar dyestuff industry ought, after the conclusion of peace, to be permitted to sell dyestuffs only in Germany and Austria, in Turkey and Bulgaria, until the German textile factories are again fully occupied and all warehouses and stores and all consumers are again supplied with good white, dyed and printed goods. Only then should it be permissible to furnish German coal-tar dyestuffs to neutral or hostile countries.
>
> "If foreign countries begin again soon to receive good German coal-tar dyestuffs, they might easily ruin the business of the German export trade in finished products.
>
> "For the German coal-tar dyestuff industry there are probably two other points to be considered; first, this industry and the German industry in coal-tar products would for the present have no right to sell raw material and by-products to foreign countries, in order not to create unnecessary competition; and, besides, it would be permissible to furnish dyestuffs to America only if the American government should promise to bury for a long time the unjustifiable so-called anti-trust question in connection with aniline-dye interests."

These and many other attempts will be made at first to strangle our new industries. It will depend as much on sound common sense of our legislators as on the skill and science of our chemists and engineers whether what we have gained so brilliantly by splendid constructive work will be lost again through political bungling and ignorance. Fortunately, we have now what we should have possessed long ago, a Tariff Commission, and the quality of the men who have been selected for this give every guarantee that they will be able to do justice to their important responsibilities, provided, however, petty business interests or sinister foreign influences do not succeed in paralyzing their work or cripple their action by simply sidetracking them as so many other useless commissions.

Power Development Important

Then there is another great problem which will have an important bearing on the future of some of our chemical industries. I refer to the power problem. In a country blessed beyond comparison with all the necessary natural resources for a large chemical industry, with a home consumption greater than that of any other country, with an enterprising population, with immense deposits of coal and other sources of fuel, navigable streams, railroads, and ever-increasing methods of land and water transportation, we, nevertheless, are very short of cheap water powers. Our great development of the electrochemical industries in the United States was due to the fact that for the first time we placed at the disposal of our industries abundant electrical current at lower rates than it had been obtainable in the past by means of steam. We became the leaders in those industries. Niagara Falls and its industries became a by-word of electrochemical supremacy throughout the world. Some of the most epoch-making inventions in this branch of chemical industry were encouraged by this condition. Since then other countries have gone us one better in the production of cheap water power. Unless we change our present condition it looks as if our electrochemical

industries, our leading chemical industries, were going to be wrested from us to find a more inviting home in Canada and in Norway. Unfortunately, here again the condition is one of "dog-in-the-manger" politics.

For purposes like electric lighting or traction, or most chemical industries, a few dollars more or less a year expressed in kilowatt-hours amounts to a mere trifle. But when it comes to making chemicals or metals at the very lowest possible cost, then every dollar counts, and here we are unfortunately face to face with the distressing fact that, with our present methods of financing, the fixed charges of our water powers amount to about 90 cents financing and 10 cents engineering. If engineers succeeded in increasing their efficiency of operation 10 per cent, it would only amount to 1 per cent in the total cost. So, if any improvements have to be made, it must be in the financial side of the problem. Meanwhile every one advances his own arguments why it should be this way, and every one is more or less right—from his personal standpoint. Capitalists say: "Some of our Government laws about the utilization of our water powers are so uncertain and threatening that we prefer to invest in less risky enterprises." Then our rates of interest in this country are considerably higher than they are in Europe. Some other persons have proposed that the United States Government should use its own excellent credit and thus be able to issue bonds for water powers at low interest, in the same way as the Panama Canal has been constructed. With our wasteful methods of financing and banking, and the many middlemen, it costs usually about 9 per cent to accomplish this result by the time the bonds are floated and put in the hands of the hesitating investor. This puts the annual cost of some of our cheapest water powers at $10 a horsepower-year, of which $9 is for interest and bonded charges and $1 for general operation and maintenance expenses, to which has to be added profit for dividends. But with interest at 4 per cent the cost per horsepower would suddenly be reduced to $5 to $7 per horsepower-year, which brings it closer to that of some of the water-power developments in Norway. Then, again, others say that the Government has no right to participate in any such enterprise, or that it is unprepared and unfit for any such business operation. To this others retort that the erection and operation of a hydroelectric plant is much easier and less expensive for the Government than for private companies, because the Government has already in its power the question of extending the navigability of streams, which, by the way, has always been a never-ending source of "pork-barrel" appropriations. Streams are made navigable by the erection of dams. By the proper selection of stream and location the cost of the dam can be made to furnish the most important part of the total outlay for a hydroelectric plant; all that is necessary is to add the turbines and the electric equipment for obtaining at somewhat increased cost a first-class hydroelectric plant, furnishing forever electric current for any purposes. A hydroelectric plant as a Government enterprise would not involve much of a new departure mpared with that splendid example of good engi-, the Panama Canal, which is a national monu- efficiency, and which, similar to the present is an asset for national defense in time of war, while in the meantime it is an aid to private shipping enterprises. The methods of hydroelectric plants are, by this time, well established and well known, and leave little scope for further improvement except the enormous cheapening which is possible for such plants in the reduction of fixed charges by very economical financing.

These are some of the dark points on the horizon of our chemical industries. What will happen depends very much whether in the future our legislators will look at everything from a political or a one-sided standpoint, or whether they shall have learned in earnest to utilize the advice of competent men, and put the welfare of the United States before sectionalism and personal political ambition.

Thursday Meetings

The manner in which the South is realizing and exploiting its industrial resources was thoroughly brought out in the symposium Thursday, with Dr. Eugene P. Schoch, of the University of Texas, presiding. The keynote of the program was given in the paper of C. H. Crawford, of the Nashville, Chattanooga & St. Louis Railway. His title was "Ahoppa Awan Tewa"—"The Dead, their Day," referring to a Zuni Indian ritual on the mythical subterranean origin of their race. The analogy was found in the way the South has "come up" and is becoming recognized as our country's greatest undeveloped asset. Other speakers and their papers were: V. V. Kelsey, "Building a Complete Cycle of Chemical Industries on the Clinchfield." T. P. Maynard, "Interpretation of the Mineral Resources along the Central of Georgia Railway," E. A. Schubert, "Development of Chemical Industries Along the Norfolk & Western Railway," J. H. Watkins, "Railroad Industrial Preparedness."

The joint session of the New York sections of the A. I. M. E. and American Electrochemical Society was presided over by Mr. J. V. N. Dorr. After introductory remarks by President P. N. Moore of the A. I. M. E. and President C. G. Fink of the American Electrochemical Society a program was presented on the production and uses of ferro-alloy metals, with relation to the war. Chrome mining and concentration, with special reference to a recent development in Canada, was presented by C. S. Newcomb. The importance of nichrome to the electrical and metallurgical industries was outlined by W. B. Driver. In the absence of S. H. Ball, his notes on ferro-molybdenum were read by the Secretary. Some impressions on conditions in the metallurgical industry of Europe gathered during a recent trip abroad, were prepared by Dr. George K. Burgess, and in his absence read by the Secretary.

Friday Meetings

One of the most important technical sessions of the exposition was that of the New York Section, American Chemical Society, at which "The Chemist and the Banker" was discussed. Mr. Arthur D. Little represented the chemist and Mr. G. A. O'Reilly, of the Irving National Bank, New York, appeared for the banker. Owing to the late hour at which this symposium was presented we are obliged to defer a full report until a later issue.

Impact Tests and the Determination of Resiliency

By Georges Charpy and André Cornu-Thenard*

The Copenhagen Congress of The International Association for Testing Materials after discussing the official report presented by one of us[1] designated a special commission (Commission No. 26) intrusted with the task of determining a working process to be adopted in resiliency tests and of studying the correlation existing between the results of those tests and the way in which the metallic parts act in service.

The researches in this paper bear only on the first question, which must be elucidated before being able to approach logically the second one. Made in 1913 and 1914, they were intended to serve as a basis for deliberation of Commission No. 26, leading to suggestions to be submitted to the Congress which was to be held at Petrograd in 1915. To make their value as convincing as possible, we took certain precautions upon which we are insistent, because it seems that while studying the present subject, experimental precision has formerly been somewhat neglected. Most experimenters who have published their researches upon the bending of metals through impacts on notched bars appear to have given up the idea of obtaining any series of results free of accidental differences. Some attribute such irregularities to the mode of testing; others blame the heterogeneity of the metals employed.[2]

It is important to decide between those two opinions; the first, to our minds, would unquestionably lead to the entire elimination of this mode of testing. As to the second, on the contrary, it would be proper to ascribe a special sensitiveness in the bending test through shocks upon notched bars capable of detecting certain physical states not revealed by any other known test, and whose influence from a practical point of view cannot be deliberately overlooked. This sensitiveness would even offer exceptional interest and justify a deep study of the question.

To demonstrate the soundness of the latter point of view, it was necessary to prepare metals which, under prescribed conditions, would give concordant results within well-defined limits at slight distances from each other. In that we succeeded, as will be seen later—and thus results were obtained the regularity of which is comparable to that given by any other mechanical test.

Moreover, when a suggestion lent itself to controversy and was the subject of contradictory determinations on the part of various experimentors it seemed to us that any new series of determinations could never be indiscriminately applied. Therefore we deemed it proper to submit the results of our own tests to a certain number of authorities for examination. We therefore invited every member of Commission 26 to witness the performance of a full series of determinations made in the Laboratory of the National Conservatory of Arts and Industry, by the staff of that institution. Our results have thus received a sort of official confirmation.[3]

The method of the prescribed work being thus clearly outlined, the subject matter of the present paper consists of three main divisions:

1. Preliminary determinations.
2. Preparation of a series of bars of equal resiliency
3. Determination of the influence of different variables.

PRELIMINARY DETERMINATIONS

Mathematical Expression of Experimental Uniformity.—It was necessary to clearly define the limits of error in the experiments to be used as a guide in procuring a series of bars of equal resiliency, and to permit us to determine beyond a doubt the influence of the various factors entering into the impact test.

The following statements apply to all kinds of experiments, especially to the shock-bending tests referred to later, and also to the hardness tests which were often made.

Suppose that n bars were tested and all broken under the same conditions; we obtain n values of the resiliency R, the arithmetical average of which gives the mean resiliency R_m. The uniformity or consistency of the experimental results is defined by noting:

The mean error e_m, which is the arithmetical average of the absolute values of the difference $(R-R_m)$ between the individual resiliences and the average resiliency; and the maximum error, or the difference between the extreme individual tests.

Likewise one may compute the mean relative error E_m, which is the ratio between the mean error e_m and the mean resilience R_m.

We may infer that the regularity of a series of determinations is satisfactory when the value of the mean error or the mean relative error is inferior to some agreed value. In practice, it suffices when the mean relative error is maintained below 5 per cent.

Determination of the Sensibility and Comparability of Apparatus.—In the first place we had to make it clear that the irregularities referred to above did not come from the apparatus but rather from the material to be tested: In other words, it was important to ascertain whether a suitably constructed apparatus, satisfactory in principle, would remain constantly consistent with itself or with any other piece of apparatus meeting the same requirements both as to principle and construction.

For that purpose, we have employed unnotched bars so as to confine the determinations to a well-defined bend without a break; in that manner the slight and local irregularity liable to exist within the metal was not perceptibly noticeable. We will not dwell upon this part of our researches—previously described in the *Revué de Metallurgie*,[4] and shall confine ourselves to presenting a few general results, so as to give first an idea of the precision obtainable with well-constructed

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*Translated from Revué de Metallurgie, March-April. 1917, 14th yr., No. 2, almost entire.

[1]This report appeared in the Revué de Metallurgie, December, 1909. See also the Report presented at the New York Congress in Revué de Metallurgie, December, 1912.

Consult the following for further information on the subject: G. Charpy.—Observations upon tests of bending metals through shock of notched bars. Bulletin, Société des Ingénieurs Civils, 1901, (I) 848 and 1904, (II) 468.

G. Charpy.—Report on testing metals by impact (Copenhagen Congress). International Association for Testing Materials; 1909, Article No. 7.

G. Charpy.—Report on impact tests and the labors of Commission 26 (New York Congress). International Association for Testing Materials; 1912, Paper No. 9.

[2]The latter opinion has been expressed clearly in a paper presented at the New York Congress by M. Belanger, in which he writes: "Even among steel known as being the most homogeneous (crucible steel, electric steel) the resiliencies vary 100 per cent within a few centimeters distance. Within a meter or two they vary 400 per cent at times."

[3]The certificate covering the experiments made during that session appears at the end of the French article and confirms the determination in every point.

[4]G. Charpy and A. Cornu.—Remark upon the calibration of impact apparatus. Revué de Metallurgie, November, 1913, page 1233.

impact apparatus and then of its application to the calibration of testing machines.

Each series of experiments summed up in one line of Table I comprises five bars. Two series of test pieces of different sizes were also tested with each one of the two pendulum-shaped blocks at our disposal.

TABLE I

Dimensions of Bar	Kind of Metal	Mean Work Absorbed in Bending	Mean Error ϵ_m kg.-m.	Mean Relative Error E_m	Extreme Value, kg.-m.
30 kg., pendulum:					
53.3x10x5	For cannon	9.954 kg.-m.	±0.093	0.9%	9.72- 10.11
53.3x10x6	For cannon	15.446	±0.216	1.4	15.04- 15.72
300 kg., pendulum:					
200x30x13	Soft boiler plate	166.508	±1.678	1.0%	163.71-169.3
160x30x15	For cannon	255.807	±1.144	0.4	254.57-258.66

The regularity presented by these tests was not easily acquired. In the course of this study we realized the importance, from the point of view of experimental testing, of the exact shape of the curved parts in contact with the bar (head knife and supports) and of the perfection of the machine work on the ones elements. Naturally we made note of those observations in the subsequent tests upon notched bars.

The examination of this table shows: First, that carefully prepared small unnotched bars give practically identical results in the same piece of apparatus, under the same conditions, and second, that the irregularities between successive tests appearing when the impact tests are used upon notched bars are not attributable to the testing machine, but rather to the tested material.

Similar tests performed with a vertical drop-hammer brought forth similar results. One may proceed still further and conclude by saying that the above certifies, first, the relative regularity of two kinds of impact apparatus, and, second, concordance or discordance in the graduations placed on these two machines.

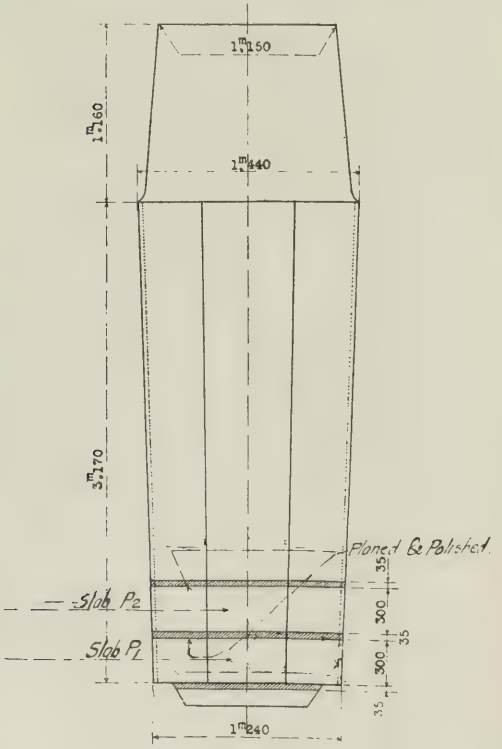


Fig. 1

Elevation of a 45-ton ingot from which has been taken the medium steel used in testing.

Slab P_2 = section of the ingot which produced the blocks for forging the test bars (regarding the distribution of these blocks, see Fig. 3); the upper face has been studied as to its structural homogeneity.

Slab P_1 = section of the ingot forming its base; the upper face has likewise been studied macrographically.

II.—PREPARATION OF BARS OF EQUAL RESILIENCY

(A) PRELIMINARY TESTS

Preparation of the Metal.—We endeavored as far as possible to exclude chemical and physical heterogeneity in the metal by having recourse to the process previously mentioned by one of us, and which consists in removing a relatively small fragment from the sound part of a large sized ingot. As to the steel (metal A) used in the greater part of our preliminary studies, we were able to carry things to extremes; indeed, we had at our disposal a 45-ton ingot from which we had cut small blocks of 25 kg., thus each of the latter represented only the 1/1800 part of the original metallic mass. We describe in full below the verifications made by us in this particular case, before utilizing the strip of the ingot reserved for our investigations.

Two slabs P_1 and P_2, 300 mm. in height, were taken out from the base of the ingot (Fig. 1), the upper sections of each of these slabs were polished, etched first with iodine and then with sulfuric acid, without manifesting any macrographical heterogeneity.

Slab P_2 was afterward sawed into two equal parts while reserving between these two parts a vertical slice T_2 50 mm. thick, so as to study the metal both from the mechanical and chemical standpoints along the height of that portion of the ingot. To that end, this slice having been subjected to a tempering so as to efface any strains due to casting, was explored over its entire surface by the Brinell principle (39 tests distributed as in Fig. 2).

These showed an average hardness of 153.4 ± 5.6, that is, a mean relative error of 3.6 per cent only. Then filings were taken from various points of the section which were analyzed and yielded very regular results, summed up in Table II.

The filings for chemical analysis were procured from the points noted in Fig. 2.

The metal showing satisfactory homogeneity, we then cut from slab P_2 parallelopipedons A, 100 x 100 x 300

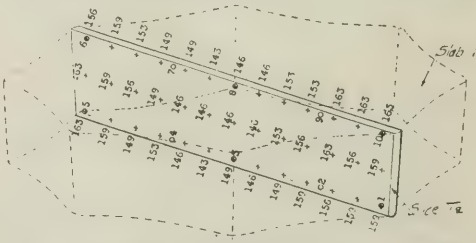


Fig. 2

Perspective view of slice T_2 removed from slab P_2 along a diametrical section. Upon this slice are indicated; first, the indentations (+) and the corresponding Brinell hardness numbers; and second, the marks (O) where filings were taken for chemical analysis.

TABLE II

	C	Si	Mn	P	S
○ No. 1	0.33–0.34	0.28	0.77	0.022	0.014
○ No. 2	0.33–0.32	0.27	0.75	0.020	0.014
○ No. 3	0.33–0.29	0.28	0.74	0.017	0.010
○ No. 4	0.33–0.28	0.28	0.74	0.018	0.010
○ No. 5	0.37–0.38	0.27	0.76	0.022	0.014
○ No. 6	0.30–0.32	0.28	0.77	0.022	0.014
○ No. 7	0.28–0.27	0.26	0.74	0.019	0.010
○ No. 8	0.26–0.32	0.26	0.72	0.017	0.010
○ No. 9	0.30–0.34	0.28	0.75	0.019	0.014
○ No. 10	0.26–0.29	0.27	0.76	0.024	0.012

mm. concentrically distributed about the axis and within the middle section of the ingot, according to Fig. 3.

Influence of Superficial Layers.—Each block formed into a square bar 34 x 34 mm. yielded a series of small bars; each of these bars was labeled with the letter denoting the metal, the number of the original block, and the serial number of the piece in the bar. Thus the eighth small piece from the bar originating from the fifth block of metal *A*, was labeled *A*. 5:8. A series of determinations comprises all the small bars bearing the same order number; thus the experiments presented under the notation *A*:6 have utilized the sixth test piece from each one of seven bars from metal *A*.

These small test bars were then reheated to efface any strain due to the rolling, machined to the dimension 30.5 x 30.5 mm., heat treated, tempered and annealed in a small oven heated with industrial gas in lots of approximately 50. The temperature was registered with Lè Chatelier pyrometers at various points in the mass.

After finishing, drilling and notching the test pieces we obtained from the impact machine the results in Table III.

TABLE III

Series of Small Bars		Individual Resiliency	R_m	e_m	E_m	Extreme Values	Individual Hardness	H_m	e_m	E_m	Extreme Values
	I	21.21					189				
	II	15.16					188.5				
	III	14.62					193				
A: 1	IV	10.19	16.57	±6.3	38.0%	27.31–4.18	188.5	187.4	±2.6	1.3%	193.0–183.5
	V	4.18					185.5				
	VI	27.31					183.5				
	VII	23.31					184				
	I	25.48					190				
	II	12.48					191				
	III	13.28					199.5				
A: 2	IV	4.78	15.27	±7.9	52.1%	25.48–2.69	186	188.8	±3.9	2.0%	199.5–180.0
	V	2.69					188				
	VI	22.72					180				
	VII	25.48					187.5				

In spite of every precaution we developed the irregularities so frequently mentioned in resiliency tests even while maintaining a constant hardness. Through certain observations, however, we were led to wonder whether the superficial layers of the test pieces had not undergone changes in the course of the heat treatments, such as to affect the results in a perceptible manner. To ascertain this we simply planed off the sides of the following small bars; thus, the 7 small bars

A:5 were planed off 1 mm. (notching section 15 x 28).
A:7 were planed off 2 mm. (notching section 25 x 26).
A:8 were planed off 3 mm. (notching section 15 x 24).

The results of the impact were then as in Table IV.

The experiment seems to be conclusive; the slight planing of the superficies lessens the mean relative error from approximately 20 per cent to 8 per cent; the hardness tests on the planed surface, on the contrary,

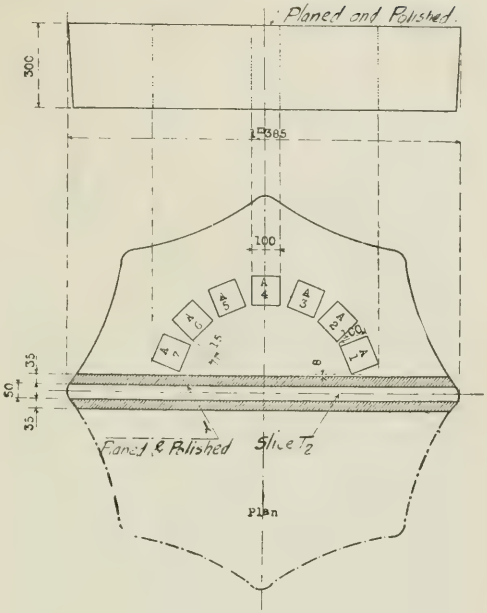


Fig. 3

Elevation and plan of slab P_2.

The plan shows blocks A, which have been cut out at equal distances from the center and the edges of the ingot, to better utilize the sound part of the metal only. Each of these blocks weighs 25 kg., which is 1/1800 part of the entire mass (45 tons).

reveal no corresponding variation but remain perfectly uniform. The elimination of the superficial layers of the bars after heat treatment is now one of the first conditions to be taken into consideration in order to realize a uniformity in the results of a series of impact tests.

TABLE IV

Series of Small Bars		Individual Resiliency	R_m	e_m	E_m	Extreme Values	Individual Hardness	H_m	e_m	E_m	Extreme Values
	I	20.51					175				
	II	23.04					174.5				
	III	10.13					182.5				
A:5	IV	27.60	19.05	±4.0	20.9%	27.60–10.13	178.5	177.0	±2.0	1.1%	182.5–174.5
	V	15.66					177				
	VI	18.35					174.5				
	VIII	18.05					177				
	I	25.73					173.5				
	II	25.73					178.5				
	III	14.36					180				
A:7	IV	22.32	21.54	±2.7	12.8%	25.73–14.36	174.5	177.0	±2.3	1.2%	180.5–173.5
	V	21.99					180.5				
	VI	21.65					176				
	VII	19.03					176				
	I	22.50					169				
	II	20.39					179				
	III	16.67					182				
A:8	IV	23.57	20.17	±1.69	8.3%	23.57–16.67	179.5	177.6	±3.3	1.8%	182.0–169.0
	V	18.00					181.5				
	VI	20.04					175				
	VII	20.04					177.5				

Influence of Temperature of Rolling.—A few experiments made upon another steel led us to think that the temperature of rolling might affect the resiliency; and to reassure ourselves of such an influence upon metal A we rolled two blocks from our 45-ton ingot, one at an approximate temperature of 1200 deg., the other at nearly 800 deg., the bars thus secured were reheated to 900 deg. and cooled in the oven; the small bars

originating therefrom were hardened and annealed, then machined to 30 x 30, drilled and notched.

Results of this test are presented in Table V.

Table V

Rolling Temperature	Number of Bars Tested	Resilience Tests			Extreme Values	Hardness Tests			Extreme Values
		R_m	e_m	E_m		H_m	e_m	E_m	
800°	5	29.05	±5.97	20.5%	44.0 -22.71	173.4	±3.32	1.9%	178.0–166.2
1200°	5	22.23	±1.17	5.2%	24.23–20.02	170.1	±1.72	1.0%	172.5–167.5

Till now we had conceded that the more or less pronounced hammer-hardening occurring in the course of rolling or forging was completely effaced by a suitably selected subsequent heat treatment. This table, however, brings out the fact that even if this is true with the hardness of the specimen, it is not true regarding its resiliency. Moreover, we verified the fact that micrography itself no longer showed any structural difference between cold-rolled and hot-rolled metal after heat treatment.

Influence of Variation in the Heat Treatment.— These first results having been acquired, we then endeavored to eliminate the influence of superficial layers and the temperature of rolling by preceding thus: Another block of metal A was rolled into a bar of 35 mm.² cross section; the latter was first quenched, then it was cut into pieces sufficient to form small bars 160 mm. long; these same fragments were subjected to a heat treatment (hardening and annealing) in the above described manner, then reduced to 30 x 30, bored, notched and tested. Series of tests were then made upon five consecutive small bars from the same strip.

The results, from among the numerous determination, were as follows:

Table VI

Metal	A
Number of bars tested	5
Mean resiliency R_m	16.3
Mean error e_m	±1.22
Relative error E_m	7.5%
Maximum resiliency	18.57
Minimum resiliency	13.81

The results shown in this table did not yet manifest the uniformity which we hoped to reach.

It seemed to us that the method of procedure in the heat treatment could be improved upon, and accordingly we determined to heat all the strips of a given series simultaneously in a lead bath.

After rolling the original blocks into bars and reheating the same, the small pieces, 35 x 35 x 160 in dimension, were arranged in groups of 14 or 23 (into bars or half bars respectively) in the basket, as shown in Fig. 4. These baskets were immersed in succession into pots of molten lead at various temperatures.

The mode of operation adopted follows:

The first bath (duration of immersion, 20 minutes) brought the metal to approximately 400 deg., the second (duration of the immersion, 30 minutes) brought it to a temperature but a few degrees lower than the desired temperature, so that the temperature of the third bath (duration of the immersion, 30 minutes) could not be perceptibly lowered (20 deg. at the maximum) by the addition of the articles. This temperature could then be maintained quite constant, and it was registered with great precision. Hardening was done by immersing the

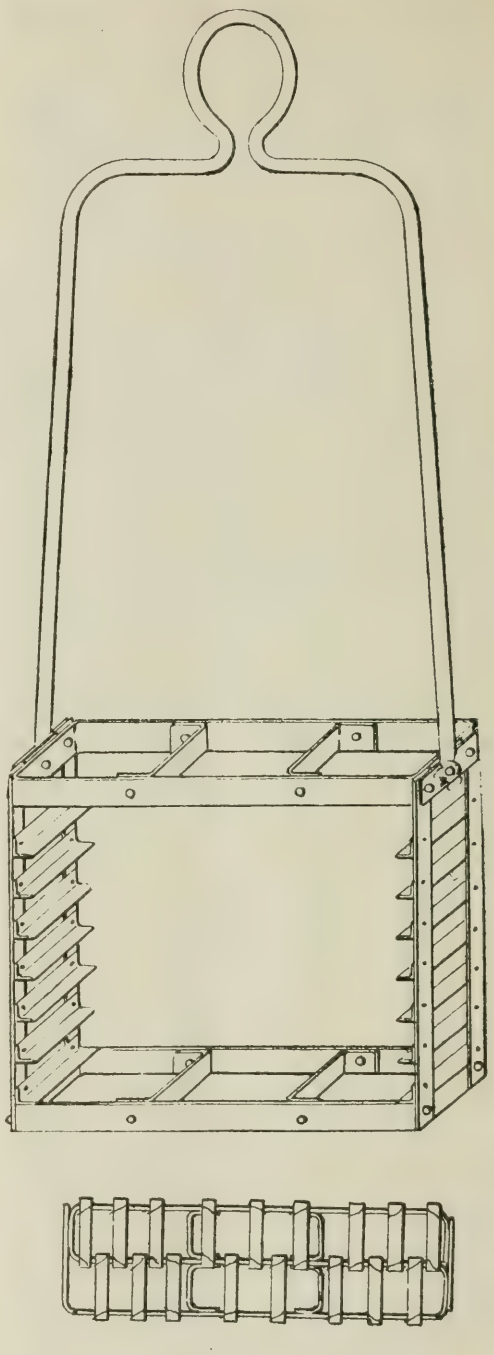


Fig. 4.

Perspective view of the type of basket used in the heat treatment of small bars and a plan of one of the shelves.

The small bars are fixed with wire and at equal distance from each other upon shelves; and the loaded shelves are placed into the basket. Then the apparatus is plunged in succession into the various metallic baths for re-heating and finally into the quenching bath.

basket and all the bars simultaneously into water or oil, according to the grade of the metal; cooling after reheating took place in air.

The bars thus treated were afterwards finished to 30 x 30 x 160, drilled and notched. The tests made under those conditions upon metal A showed a uniformity superior to any previously obtained; the results are included in the following paragraphs:

FINAL TESTS

Summary of Results.—Table VII sums up the results obtained with Metal A, in small bars of 30 x 30 and 10 x 10.

TABLE VII

Series		Types of Small Bars (Copenhagen Notch)	Individual Resiliency	R_m	e_m	E_m	Extreme Values
Metal A:	I	30x30x160 mm.	23.01	24.11	±0.88	3.6%	25.48–23.01
	II		24.85				
	III		24.23				
	IV		25.48				
	V		23.01				
	1	10x10x53.3 mm.	16.18	16.42	±0.20	1.2%	16.92–16.18
	2		16.43				
	3		16.92				
	4		16.43				
	5		16.18				

The uniformity of this series of tests is amply sufficient; it is clearly superior to all those heretofore reached: we may infer therefrom that the preparation of the bars is satisfactory. We then took blocks from a medium-steel "J" containing 1 per cent nickel (original ingot, 25 tons), which were subjected to the successive operations described in the preceding paragraph. For comparison, we added a series of commercial copper bars quenched at 800 deg. to these two series of steel bars, each having five members. The results obtained are shown in Table VIII.

Conclusions.—Results shown in Table VIII prove the possibility of reaching a uniformity analogous to that of tension or hardness tests in resiliency tests upon steel bars of various compositions or upon copper. Moreover, the series of experiments previously summarized clearly undermines the opinion of some authors, partisans of the sharp notch, that the sensitiveness of the impact test is considerably lowered by the use of the cylindrical notch called "Copenhagen." We find complete concordance with the same metal and with the same shape of bars cylindrically notched when due care is taken and incoherent results otherwise. The regularity obtained is due to an improvement in the mode of preparing the test material.

TABLE VIII

Series		Types of Bars (Copenhagen Notch)	Individual Resilience	R_m	e_m	E_m	Extreme Values
Metal J	I	30x30x160 mm.	18.10	17.89	±0 13	0.7%	18.10–17.81
	II		17.81				
	III		18.10				
	IV		18.10				
	V		17.81				
	1	10x10x53.3 mm.	12.16	12.48	±0.34	2.7%	13.07–11.93
	2		12.62				
	3		12.62				
	4		13.07				
	5		11.93				
Metal P	I	30x30x160 mm.	10.08	9.98	±0.15	1 5%	10.08–9.59
	II		9.59				
	III		10.08				
	IV		10.08				
	V		10.08				
	1	10x10x53.3 mm.	5.13	4.76	±0 15	3.3%	5.13– 4.63
	2		4.63				
	3		4.63				
	4		4.79				
	5		4.63				
Copper	I	30x30x160 mm.	12.35	12.14	±0.27	2.2%	12.61–11.83
	II		12 09				
	III		11.83				
	IV		12.61				
	V		11.83				
	1	10x10x53.3 mm.	4.76	4.95	±0.23	4.6%	5.41– 4.76
	2		4.76				
	3		5.08				
	4		5.41				
	5		4.76				

These observations made, we may sum up the precautions taken by us in producing a series of uniform bars as follows:

First—It is important, of course, to select a sample of homogeneous metal taken from the soundest part of an ingot; but the results on steel P, coming from a stock ingot of 2.5 tons, show clearly that it is useless to insist upon abnormally large blocks of metal.

Second—The superficial layers of the bars after rolling and heat treatment are to be eliminated. The disturbances on the surface (which are to be explained later) are more or less pronounced according to the nature of the metal. Usually, we begin with bars of 35 x 35 mm. for the preparation of smaller bars 30 x 30, and with bars of 15 x 15 mm. for the preparation of smaller bars, 10 x 10.

Third—The temperature of forging or rolling is to be as uniform as possible within the same series; especially in the case of the single bar it is well to discard a large portion at each end so as to eliminate the parts which are abnormal.

Fourth.—It is indispensable that thermal treatments be given under conditions as regular and precise as possible.

III.—INFLUENCE OF THE DIFFERENT VARIABLES IN THE IMPACT TEST

We were enabled to study the influence of the different variables which may intervene in the impact test, having once established a homogeneous material. It was no longer necessary to consider a quantity of more or less discordant results, or to note its average while having recourse to the theory of errors. In our tests we simply broke five bars for one determination. We give in Table IX the mode of operation adopted.

Precision of the Adopted Method.—It is necessary to ascertain whether the variation of one of the conditions of the test had or had not a perceptible influence upon the results. To do this we prepared a series of ten small bars as uniform as possible, and then determined the mean resiliency R_m of the series by breaking five of them in a normal manner. It is conceded that the same mean resilience R_m could be obtained after trying likewise the other five, within an approximation of $\pm n$ per cent.

We then vary that condition of the test under examination and break the five remaining bars, which gives a mean resiliency P_m.

We regard the said influence as practically negligible if the difference R_m—P_m is nearly n per cent, the number which defines the precision of the experimental results, as noted above.

These preliminary definitions established, we studied in succession the influence of the following different variables: Height of drop, weight of the pendulum and

TABLE IX

Series			Height of Drop	Velocities, M. Initial	Remaining	Mean	Duration of the Test. Sec.	Individual Readiences	R_m	e_m	E_m	Extreme Values
		I						9.84				
		II						8 91				
		III						9.38				
	6	IV	6 45	11.25	10.28	10.76	0.0012	10 31	9.76	±0.61	6.2%	10.31– 8.91
		V						10.31				
		VI						9.84				
		I						9 86				
		II						8 01				
Steel		III						8 94				
O	7	IV	4.31	9.20	8 20	8 70	0.0015	9.86	9.55	±0.71	7.5%	10 79– 8 01
		V						10 79				
		VI						9.86				
		I						10 67				
		II						9 29				
		III						9 62				
	8	IV	2.20	6 57	5.11	5.84	0.0022	9 97	9.97	±0.34	3.4%	10 67 – 9 29
		V						10.32				
		VI						9.97				
		1						18.10				
		2						17.81				
		3	3.87	8.87	7.55	8.21	0.0036	18.10	17.98	±0.13	0.7%	18.10–17 81
		4						18.10				
Steel		5						17.81				
J 1		6						18.15				
		7						16.68				
		8	1.15	4.83	1.83	3.33	0.0090	17.08	17.28	±0.56	3.2%	18.15–16.68
		9						17.81				
		10						16.68				
		1						10 08				
		2						9 59				
		3	3.87	8.87	8 14	8.50	0 0015	10.08	9 98	±0 15	1 5%	10 08– 9 59
		4						10.08				
		5						10.08				
Steel												
P I		6						9.63				
		7						9 85				
		8	0 58	3 44	0 70	2 07	0 0062	10 21	9.79	±0 19	1.9%	10 21– 9 51
		9						9 75				
		10						9 51				
		1						12 35				
		2						12.09				
		3	3.87	8.87	7.99	8.43	0.0035	11.83	12.14	±0.27	2 2%	12 61 11 83
		4						12 61				
Copper		5						11.83				
		6						11.34				
		7						11.42				
		8	0.71	3 80	1.25	2.50	0 0120	11 34	11.12	±0 29	2 6%	11.42–10 71
		9						10 81				
		10						10.71				

of the anvil block, type of the apparatus, and type of the notch.

Influence of the Height of Drop.—The height of drop of the block in impact tests is often thought to have great influence; however, it is diversely interpreted. While M. Belanger admits diminutions of the resiliency up to 100 per cent as the height of the fall lessens from 4 m. to 1 m., M. Fremont announces differences for a certain steel which he does not reduce to figures, but which he seems to consider as being still more important than those indicated by M. Belanger, but of opposite effect.

The tests offered here were made on two different pendulum-shaped blocks: one having a maximum fall of 6.45 m., the other 3.87. Table IX gives the results of this experimentation. The bars employed were Copenhagen type, 30 x 30 x 160.

Those tests bring out the fact that the influence of velocity in the impact is practically negligible within the limits used by us (11.25 m. to 3.40), and which are not exceeded with the ordinary laboratory apparatus.[5]

The small effect of the height of drop is more easily understood as one considers not the velocity of impact (or height of drop), but the mean duration of deformation, whose variations are much less pronounced. One may approximately compute the time of deformation, having given the initial and final velocities. In operating thus upon the experimental results we realize, in the case of steel P for instance, that the drop height may vary in the proportion of 7 to 1, and similarly the remaining velocity after impact in the proportion of 12 to 1, without the average duration varying more than 15 to 62/10,000 of a second.

Besides, one may compare this result with the one reached by Sarreau and Vieille, in their remarkable experiments upon the measurement of pressure in explosions where they found that the deformations produced in their cylinders at a given pressure remained practically identical, when the duration in the impact varied 1/10 to 3/10,000 of a second.

One of us had previously demonstrated that, to have the results of the test influenced in a perceptible manner, the average duration of the deformation must be greatly increased; it is not surprising then that the slight variations in the duration of deformation attainable in impact tests are without noticeable influence upon the results.

Influence of the Block Weight and That of the Anvil Block.—Facing a difficulty in defining clearly what is meant by the expression "anvil block weight" we resolved to compare two like pieces of apparatus with each other; the principal difference being in their size. The question of the height of drop being eliminated, the only two variables in this test were consequently the weight of pendulum and of the anvil. (See Fig. 5.)

To that end, two pendulums were used: one of 307

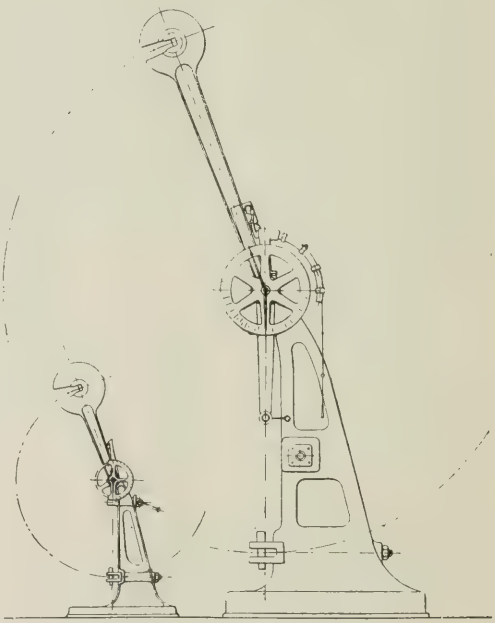


Fig 5.

Diagram of the two pendulum-shaped blocks used to study the influence of the weight of the striking mass and that of the anvil block.

On the right: the 307 kg-m. pendulum; weight of the striking mass, 96.25 kg.; drop height, 3.87 m.; weight of the foundation frame, 1800 kg.

On the left: the 30 kg.-m. pendulum; weight of the striking mass, 22.31 kg.; drop height, 1.45 m.; weight of the foundation frame, 190 kg.

[5] This result has been fully confirmed by the experiments made at the Conservatory of Arts and Industry

kg-m. (weight of the mass, 96.25 kg.; height drop, 3.87, support distance, 80 mm.); the other 47 kg-m. (weight of the mass, 32.14 kg.; drop height, 1.49; support distance, 80 mm.).

The ten small bars of one single series (20 x 20 x 107 mm. notched half way through) were distributed into two lots of five; one of those lots was tested upon the 307 kg-m., the other upon the 47 kg-m. apparatus.

The results were as follows:

TABLE X

	R_m	e_m	E_m	Extreme Values
307 kg-m. block	18.61	±1.04	5.6%	20.2 16.52
47 kg-m. block	19.90	±1.70	8.5%	21.96 16.99

From the average relative error denoting the precision of the test, these two results may be practically considered as identical. The 47 kg-m. pendulum was of old construction and seemed to undergo deterioration in use. We therefore resumed the same tests with a new apparatus, reducing the dimensions of the small bars to 15 x 15 x 80 mm.

In this second series of determinations we used (Fig. 5):

1st.—The same 307 kg-m. pendulum as above (distance of supports, 60 mm.);

2nd—A 30 kg-m. pendulum (weight of the mass, 22.31 kg.; drop height, 1.45 m.; distance of supports, 60 mm.).

The weights of the foundation frame of the two apparatus were respectively 1800 kg. (307 kg-m. block) and 190 kg. (30 kg-m. block). It is to be presumed that the weight of the anvil block was approximately proportional to the weight of the frame

We give in Table XI the results obtained:

TABLE XI

Pendulums	Series of Bars	Individual Resiliencies	R_m	e_m	E_m	Extreme Values
307 kg-m	C. 11	I 19.72 II 18.97 III 17.48 IV 18.97 V 18.22	18.67	±0.65	3.5%	19.72–17.48
30 kg-m.	C. 12	I 19.31 II 18.44 III 15.93 IV 17.77 V 18.22	17.93	±0.86	4.8%	19.31 15.93

This time the consistency of the individual determinations of each series is very satisfactory, and the mean resiliencies differ only from each other by 0.74 kg-m., that is, by 3.9 per cent of the higher figure.[6]

Hence we may conclude that, within the limits of precision reached, the weight of the pendulum block and that of the anvil block do not exert any influence over the impact test.

The results presented above seem to us so much the more interesting because in these experiments the two apparatus acted in a manner quite abnormal. Breaking the bar took up hardly the tenth part of the available power of the larger while it took up almost the full power of the smaller.

Contrast Between Various Types of Apparatus.—

[6]This series of determinations was duplicated at the Conservatory under analogous conditions. The mean resiliencies obtained were respectively of 21.07 and 20.41; they reveal a concordance which confirms amply the one obtained under the above tests.

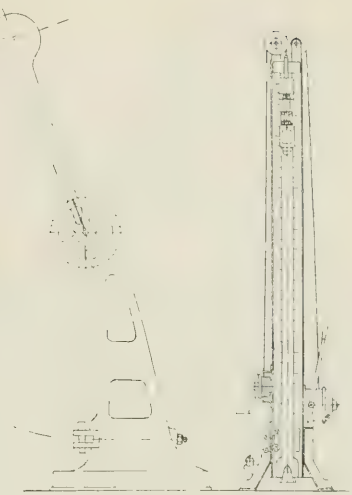


Fig. 6.

Sketch of the pendulum and of the drop hammer used to study the similarity between those two types of apparatus.
On the left is the 307 kg-m. pendulum; weight of the striking mass, 96.25 kg.; drop height, 3.87 m.
On the right is the drop banner; weight of the striking mass, 18.28 kg.; drop height, 3.05 m.
The concordance of the results obtained with this apparatus is satisfactory.

Having thus established the practical identity of the results obtained by impact by two apparatus of the same type, yet differing greatly from each other in dimension, we proposed to ascertain if the various types of usual apparatus were comparable.

Pendulum vs. Drop Hammer.—Our first experiments were on a pendulum and a drop-hammer (Fig. 6); it was natural to investigate the qualitative similarity.

To that end we made a group of $4n$ uniform bars and determined the mean resiliency of the lot by breaking $2n$ of them with a pendulum. Let $T_m \pm 2$ per cent be the mean work to break each of these bars. We then computed the height H from which we had to drop mass P of the hammer so that

$$PH = T_m$$

This being solved, we let the mass P drop: 1st—From a height 0.90 H, upon n of the remaining bars. None of them were broken. 2nd—From a height 1.10 H upon the remaining bars. They were all broken. We tested in succession a hammer weighing $p = 18$ kg. and one weighing 75 kg.; in both cases these results held in spite of the variation in weight of the mass and the height of fall.

Qualitatively then, the pendulum and the drop hammer are consistent; this degree of similarity had now to be computed. To that end, we placed an Amsler-Laffon register upon the drop hammer which precisely determines the velocity both before and after break, and furnishes data with which to compute the work of fracture. The bars were of the Copenhagen type, 30 x 30 x 160. The distance between the supports was 120 mm. for both apparatus.

Table XII sums up the results obtained.

The two mean resiliencies differ from each other by only 0.74 kg-m., that is: 7.1 per cent of the higher figure.

Table XII

Type of Apparatus	Height of Drop, m.	Hammer Weight, Kg.	Mark on Bars	Individual Resiliency	R_m	e_m	E_m	Extreme Values
Pendulum..	3.87	96.25	P II	1 10.44 2 10.44 3 10.44 4 10.44 5 10.19	10.39	±0.08	0.7%	10.44-10.19
Drop hammer..	3.05	18.28	P II	6 9.95 7 9.20 8 9.67 9 9.52 10 9.91	9.65	±0.23	2.4%	9.95- 9.20

Considering the crude arrangements made in setting up the register and putting up the hammer and its supports, the indications of the two are in very satisfactory agreement

Pendulum vs. Rotating Block.—Experiments made at the National Conservatory of Arts and Industry have used Charpy 300 to 30 kg-m. pendulums, Guillery vertical and rotative blocks of 275 and 60 kg-m. We do not need to emphasize again the results of the comparison between pendulums and drop hammers and which have only confirmed the results previously presented. But we deem it our duty to call attention to the comparative tests made upon the Guillery and Charpy apparatus, the indications of which were practically identical in spite of the essential difference in principle which characterizes the two types of instruments (Fig. 7).

Table XIII sums up these experiments.

Table XIII

Apparatus	Material	Impact Velocity	Mean Resilience	Mean Error	Mean Relative Error	Extreme Values
30 kg-m. Charpy pendulum	J_{10}	5.519 m.	18.55	±0.25	1.3%	19.01–18.24
60 kg-m. Guillery rotator	J_{10}	8.858 m.	18.4	±0.34	1.9%	18.9 –18.0
300 kg-m. Charpy pendulum	J_{30}	9.637 m.	18.78	±0.45	2.4%	19.64–18 21
275 kg-m. Guillery rotator	J_{30}	8.858 m.	20.45	±0.71	3.5%	21.78–19.78

J_{10}: Metal: J, 5 Bars: 10x10x53.3, Round notch, 0.7 mm., Supports at 40 mm.

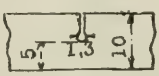
J_{30}: Metal: J, 5 Bars: 30x30x160, Copenhagen notch, Supports at 120 mm.

Here again we notice that the comparison between these two types of apparatus is very satisfactory. The computed results would be still nearer if the calculations were made in the same way in both cases. However, the mathematical attachments of the Guillery blocks do not duly take account of the power absorbed by the velocity of the fragments after the break, while those of Charpy pendulum subtracts that energy.

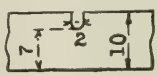
Hence we may conclude that the resiliencies obtained upon a uniform bar are practically identical, whatever may be the height of drop or the weights of the striking mass and the anvil block, or the type of apparatus employed, (within the limits of current practice). To make uniform impact tests on a single bar, it suffices to fix a few material requisites a priori and arbitrarily such as the distances between supports, the shape of the rounded off parts of the supports and those of the head-knives.

Influence of the Type of Notch.—The tests previously expounded were performed upon bars of the Copenhagen type, or their immediate relatives shown below:

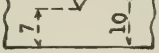
Table XIV



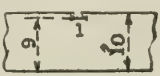
Round notch A; remaining section 10 × 5 = 0.5 cm². Drilled and cut with saw.



Round notch B; remaining section 10 × 7 = 0.7 cm². Drilled and cut with saw.



Sharp notch C; remaining section 10 × 7 = 0.7 cm² milled.



Square notch D, remaining section 10 × 9 = 0.9 cm². Made with old saw.

The shape and dimensions of the notch not having yet been standardized, it is necessary to determine the influence of the nicking on the rupture-work per square centimeter.

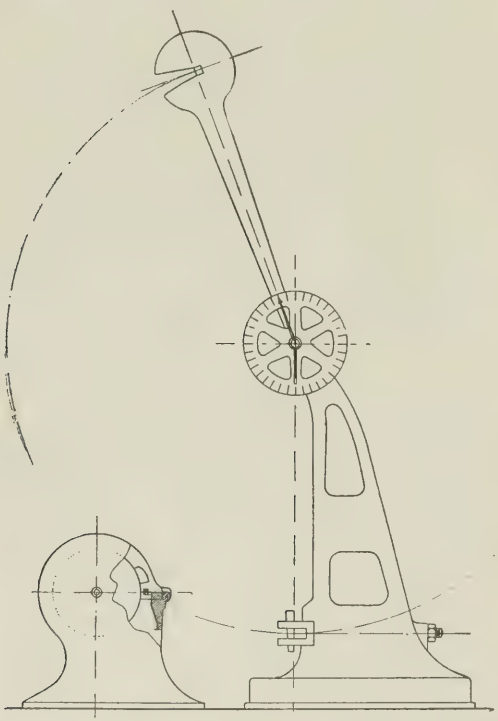


Fig. 7.

Diagram of the Guillery rotating block and of the Charpy pendulum used to compare these two types

On the right the 300 kg-m. pendulum.

On the left the rotating block of 275 kg-m.

Not only the shapes and dimensions of the instruments, but also the principle are very sharply contrasted. In spite of that, the resiliencies obtained are perfectly consistent.

TABLE XV

Kind of Metal	Notch	Rupture Work, kg-m	Resiliency,	R_m e_m	E_m	Extreme Values
Medium carbon steel "E"	A	7.363	14,72	14.96 ±0.28	1.9%	15.45–14.49
		7.243	14,49			
		7.604	15,20			
		7.725	15,45			
		7.483	14,96			
	B	16.254	23.22	23.33 ±0.29	1.2%	23.79–23.02
		16.120	23.02			
		16.656	23.79			
		16.522	23.60			
		16.120	23.02			
	D	Not broken	>33	>33 ±0 29	1.2%	23.79–23.02
Medium nickel steel "J"	A	6.080	12.16	12.48 ±0.34	2.7%	13.07–11.93
		6.308	12.62			
		6.308	12.62			
		6.538	13.07			
		5.967	11.93			
	B	11.157	15.93	16.69 ±0.45	2.7%	17.26–15.93
		11.421	16.31			
		11.189	16.88			
		11.952	17.07			
		12.085	17.26			
	C	9.342	13.34	13.19 ±0.18	1.4%	13.52–12.98
		9.088	12.98			
		9.088	12.98			
		9.215	13.16			
		9.469	13.52			
	D	20.545	22.82	22.37 ±0.53	2.4%	23.10–21.13
		20.792	23.10			
		20.296	22.55			
		20.045	22.27			
		19.025	21.13			
Medium Cr-Ni-Steel "P"	A	2.567	5.13	4.76 ±0.15	3.3%	5.13– 4.63
		2.313	4.63			
		2.313	4 63			
		2.397	4.79			
		2.313	4.63			
	B	3.954	5.64	5.70 ±0.07	1.2%	5.79– 5.64
		4.054	5.79			
		4.054	5.79			
		3.954	5.64			
		3.954	5.64			
	C	2.481	3.54	3.32 ±0.08	2.5%	3.54– 3.18
		2.313	3.30			
		2.230	3.18			
		2.313	3.30			
		2.313	3.30			
	D	5.304	5.89	5.36 ±0 22	4.2%	5.89– 5.06
		4.875	5.41			
		4.665	5.18			
		4.770	5 30			
		4.561	5.06			

To determine this we experimented on 10 x 10 x 53.3 bars and adopted the four types of notching as shown. Table XV summarizes the results obtained upon a 30 kg-m. pendulum which establishes the following points (sharp notches not being included).

In reference to unbroken pieces, the resiliency increases as the depth of the notch lessens; it even doubles in very resilient steels when we pass from the notch half through the piece to that only 1 mm. deep.

The resiliency varies but very little with the depth of the notch in fragile metals.

If we consider the sharp notch, it will be seen that: In unbroken bars, it gives results analogous to those of a deeper round notch, and it gives lower results with brittle metals.

These experiments, confirmed by the determinations made at the Conservatory of Arts and Industry, establish the importance of precision in notching. They reveal how certain experimenters have come to the conclusion that the relation between fractured area and original area is immaterial for brittle metals. They show, moreover, how other metallurgists using shallow notches exclusively attribute resiliencies to ordinary metals greatly exceeding those which are generally attributed to steels of the same grade.

It is indispensable to employ only standardized types of bars—from a scientific standpoint to permit comparison between experiments made in different laboratories; from a practical standpoint to be able, if necessary, to take notes of precise meaning.

Most experimenters agree in admitting that notching must be geometrically defined; its depth and radius would then remain to be arbitrarily fixed. From the results shown above and considering the advantage of the rigorous localization in the break, it is evident that preference be given to deep notching. The influence of the radius of the cylindrical cavity appears to be quite secondary.

Influence of the Dimensions of the Bars.—It would be evidently desirable to be able to adopt a standard bar, but this runs against real difficulties in practice.

Under such conditions it is proper to ask if there is a simple relation between resiliencies determined upon bars of the same metal but of various shapes. It has been presumed from the first that it would suffice to have notched test pieces similar geometrically to secure comparable results. Tables Nos. VII and VIII clearly weaken that interpretation and reveal that the resiliency in one and the same metal varies considerably if it is determined with bars 30 x 30 x 160, or with smaller bars, 10 x 10 x 53.3. Variation is always produced in the same direction, whether it be steel or copper, the resiliency increasing with the dimensions of the bar. The ratio is not constant, changing from 3:2 for the toughest steel to 4:2 for the most fragile steel, and to 5:2 for copper. These facts have been recognized before by numerous authors experimenting independently, as may be inferred from the report presented by one of us at the New York Congress in 1912.[6]

A theoretical study published in 1911 by Captain Mimey,[7] led to the conclusion that the deflections B_1 and B_2, whether in notched bars or straight bars, if of a proportional ratio devoted by "a" would absorb an amount of work T_1 and T_2, varying as the cubes of the corresponding dimensions, if the striking masses M_1 and M_2, the heights of drop H_1 and H_2, and the distances of the supports D_1 and D_2 were as

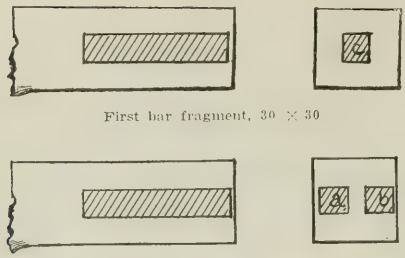
$$\frac{M_1}{M_2} = \sqrt{\frac{H_1}{H_2}} = \frac{D_1}{D_2} = a$$

Unfortunately our experiments seem to show that this relation, attractive in its simplicity, is not acceptable to the demands of practice. In the course of our paper we have indeed brought out the fact that the work absorbed in breaking a bar is independent both of the weight of the striking mass and of the height of drop. In other words, the work absorbed is practically independent of the available energy and of the velocity of the block at the moment of impact. The additional conditions given by Captain Mimey do not consequently suffice, *a priori*, to compare the resiliencies obtained with two similar test pieces. We have verified it repeatedly, but will confine ourselves to presenting two of the determinations: one upon copper and the other upon the special steel *P*. These two metals were selected to assure the highest possible homogeneity in the inner structure.

The experiments were conducted in the following manner: We had two geometrically similar pendulums with masses of 96.250 kg. and 32.140 respectively. To have these operate similarly it sufficed that the pendulum

[6] Georges Charpy.—Report upon Impact Tests, and the Activities of Commission 26. New York Congress (1912). International Association for Testing Materials, IV (p. 3 e.s.).

[7] "Remarks upon Impact Tests" Revue d'artillerie (July, 1911).



First bar fragment, 30 × 30

Second bar fragment, 30 × 30

Fig. 8. Method of cutting 10 × 10 × 53.3 bars from 30 × 30 × 160 fragments

have a free fall of 160 deg. and the second a free fall of 58 deg.

Five 30 x 30 x 160 bars (cylindrical notch 4 mm. diameter at center) were then broken by a fall of 160 deg., establishing a series of equal resiliency. Then pieces of two bars of this series were selected at random, from which were cut six small bars, 10 x 10 x 53.3 (cylindrical notching of 1.3 mm. in diameter at center), according to the sketch, Fig. 8.

Table XVI

Metal	Test Bars: Size	Marks	Resiliency	Mean Resiliency	Mean Error	Mean Relative Error	Extreme Results
Copper	30x30x160	Cu I: 1	12.35	12.14	±0.27	2.2%	12.61 11.83
		2	12.09				
		3	11.83				
		4	12.61				
		5	11.83				
	10x10x53.3	Cu I: 2—a	5.41				
		b	4.76				
		c	4.76				
		Cu I: 3—a	4.76	4.87	±0.18	3.7%	5.41 4.76
		b	4.76				
		c	4.76				
Steel "P"	30x30x160	P I: 1	9.94	9.55	±0.38	4.0%	9.94 9.46
		2	9.46				
		3	9.46				
		4	9.46				
		5	9.46				
	10x10x53.3	P I: 1—a	4.76				
		b	4.76				
		c	4.76				
		P I: 2—a	4.76	4.76	±0.0	0	4.76
		b	4.76				
		c	4.76				

These six small bars were then broken upon the small pendulum with a fall of 58 deg.

With these conditions the results obtained both upon copper and steel were as in Table XVI, which establishes:

1st.—That the metal is homogeneous, since the small bars a and b act identically as the small bar c.

2nd.—That the resiliencies given by the 10 x 10 bars are distinctly different from the resiliencies offered by the 30 x 30 bars.

Hence we are justified in saying that the law of similitude does not apply to notched impact tests.

The conclusions arrived at by Captain Mimey are applicable however when a deformation short of fracture is produced through impact on unnotched bars. Indeed the deformations are then affected solely by the volumes of the bars and may be to one another like the cube of the corresponding dimensions. But as one of us already observed[8]: If we reach the breaking point one must add the work corresponding to the separation of the two halves of the bar, a work which may be considered, as a first approximation, as being proportional to the square of homologous dimensions. It would be necessary then to use a formula of two terms as

$$a\,x^2 + b\,x^3$$

to account more accurately for the phenomena. However, tests undertaken for the purpose of verifying this interpretation have not yet given sufficiently clear results to come to a precise conclusion; they even seem to bring out the fact that the order of complexity in the relation sought is even superior to the formula.

Conclusions.—In the course of this study we have been led to seek a precision which naturally would have no *raison d'être* in practice; in most cases it suffices indeed to know whether a metal is fragile or no, and the knowledge of its resiliency, to a limit of 1 or 2 per cent matters little.

Yet it was desirable to establish groups of uniform determinations, so as to settle as definitely as possible a whole series of questions under debate for the past ten years.

In a general way, we believe we have demonstrated clearly that measurements of resiliency are capable of a precision analogous to that obtained with other current tests in metallurgical laboratories such as tensile, hardness, etc.

We have shown also that impact tests upon notching do not offer any direct correlation with the other ordinary tests, and are infinitely more sensitive to the influence of certain details in the working of metals. It seems entirely probable even if it is not wholly established, that these influences act equally upon the way in which steel performs in service, but even if not, it is assuredly unwise to neglect the mode of investigation which reveals them.

Having a homogeneous material to work upon we were enabled to study with assurance the influence of the various factors within the impact test. Hence we succeeded in drawing a series of conclusions which may be briefly laid down as follows:

1st.—The apparatus used by us for the impact of different types (vertical blocks, pendulum-blocks and rotative blocks) and of different dimensions give practically identical resilience, if the distance between supports and the radii of the rounded off parts coming in contact with the bar during the test be made the same. For those rounded off parts we have adopted a radius equal to that of the cylindrical portion of the Copenhagen notch made upon the corresponding bar (that is $r = 2$ mm. for 30 x 30 bars and 0.66 mm. for 10 x 10 bars. Moreover, we discovered that it was necessary to provide very careful machining and maintenance. To obtain comparable results it is not necessary to fix *a priori* a type of testing machine; it suffices to operate a well-constructed, well-graduated apparatus of any size comprised within ordinary limits. The agreement between the graduations between any two given instruments and the standardization of an instrument with itself, can be numerically computed by a calibration test, which is a simple bending test on an unnotched bar.

2nd.—The numerical value of the resiliency can only be interpreted when we indicate at the same time the shape and dimensions of the bar and the notch. No law is yet known for the computation of the resiliency of bars of differing dimensions.

[8]G. Charpy—On an experiment upon metals by the bending of notched bars. Records of the Society of Civil Engineers of France (October, 1914).

Finally one may ask: What is the practical value of these tests? We propose to consider this question further, but it is too intricate to be treated casually. At present we only state the problem while emphasizing its importance, as great for the producer as for the consumer.

Packing and Plant Handling of Hazardous Chemicals*

By N. A. Laury†

Many have sought for a safe and economical package for the transport of the convenient quantity of one or two hundred pounds of acid or other corrosive liquid, but nothing has yet been suggested that equals the standard form of wood-packed glass carboy for general use. This has weak points and is the cause of some accidents, but if the requirements of the Interstate Commerce Commission as to quality of material and construction and testing are faithfully followed and certain precautions in handling are taken, the present package can serve at least safely until the arrival of a more practical substitute.

The mechanical appliances in use for handling carboys are nearly all economical and much safer than the simple picking up of the carboy by one or two men when a loose stopper or defective box may cause injury. The successful use of conveyors, roller skids, derricks with ice-tong grips or the various forms of trucks depends on plant arrangements and the intelligence of the workmen. Two sticks passed under the side cleats and handled by two men may, at times, be the cheapest way and all are safer than direct handling. Full carboys should never be moved unstoppered. If nothing else is available, an inverted tin can may prevent dangerous splashing.

The use of compressed air to empty glass carboys is dangerous. The bottles often burst or some acid is invariably left to be returned in a supposedly empty package. This has caused many accidents, and as it is also to the consumer's advantage to keep all of the contents, he should see that returned empties are thoroughly drained. It appears that otherwise the Interstate Commerce Commission will require that empty carboys be washed before shipment.

Breakage of carboys is sometimes caused by partial crystallization of the contents. For example, sulphuric acid of strengths between 60 and 66 deg. Bé. and glacial acetic acid easily freeze and may on warming contain part of the acid, as a large floating solid mass which easily breaks the bottle unless it is handled with unusual care or first thoroughly thawed out.

The use of hand hooks is a quick and safe way for men on a platform or the tail of a truck to receive carboys handed to them from the ground, but by far the safest manner of raising carboys a short distance is by roller skid.

There is in current use a stoneware stopper and plaster of paris tied down with cloth, the latter sometimes coated with tar or paraffin. If the plaster is mixed in small quantities and applied fresh, it holds so solid that one may move the carboy about by the stopper, but in a few days the acid loosens the grip of the plaster and the cloth, even when treated, in time crumbles away. The safest practicable stopper in use consists of a glass or stoneware plate held on by a wire clip like a fruit jar. The joint is made tight by grinding the upper surface of the lip and using a tar paper asbestos or rubber gasket according to the acid shipped. The best form of clip is that in which the wire ends grip into holes in the sides of the bottle neck. These holes may be molded in new bottles or ground into old ones.

Carriers forbid the return of empties unstoppered. Customers therefore return empties loosely stoppered and vibration of the stopper in transit chips the bottle necks so that many cannot be refilled and some that are refilled prove a risk. This cannot happen with the fruit-jar style of stopper.

The familiar form of hand truck in use at freight stations does very well for barrels, but if a carboy with an old-style stopper is picked up with it the bottle must rest on its side while the truck is laid down to be unloaded. Leaks are thus often started with bad results. The fruit-jar form of stopper is proof against this risk.

Of course, the latter stopper is a hermetical seal and the bottle is under a pressure which depends on the temperature and the air space left in the bottle. A carboy filled outside in winter and thus sealed may develop a dangerous pressure if stored in a warm warehouse, but a 10 per cent air space safely covers even this extreme.

The greatest danger in the handling of carboys is the sudden giving away of the bottom or sides of the box due to the corrosion of the nails or weakening of the wood by acid, especially after long storage. This danger can be just about eliminated by the use of wood preservative.

It has been observed at one plant for some years that carboy boxes last two years under normal conditions. During this period the box has to be renailed three times and requires one new bottom and one new cover. Somewhat over two years ago several hundred boxes were treated with different preservatives and put into service along with some untreated boxes and records kept of their repairs. The treatment consisted of merely dipping the new box in the cold preservative.

It was found that all the preservatives tried made the boxes wear better. The materials used were ordinary coal tar creosote at 25 cents a gallon, avenarius carbolineum at 80 cents a gallon, S. A. wood preserver at 60 cents a gallon, and Preservol at 50 cents a gallon. The latter proved to be the best, as it dried in a few minutes and left a waterproof coating on the surface of the wood, while the others were deeply absorbed.

The carboys treated two years ago are still in service, and very few of them have required renailing and none have had new covers or bottoms. This is due as much to the protection of the nails from rust as to the protection of the wood from acid. These treated carboys should easily last two years longer.

All of the above applies largely to the standard lead carboy for the transport of hydrofluoric acid. Steel drums are used for this purpose in Europe, and are said to be safer and cheaper, but they are not yet accepted for rail shipments in this country.

*A paper read at the New York Meeting of The National Safety Council.

†Supt. Camden and Easton Works, General Chemical Co.

The lead carboy is subject to a pressure test prescribed by the Interstate Commerce Commission before each filling, and it must also come up to other requirements as to material and construction, and if properly handled it is safe if not economical.

These carboys sometimes burst due to high pressures which are unexplainable under the normal conditions of their use. The cause has often been traced to the presence of foreign matter. It is a package that is particularly hard to wash, and if a consumer puts it to other use in his plant and returns it uncleaned it may pass the usual washing before filling and still retain all the foreign matter necessary to generate a bursting pressure.

Owing to the very serious nature of hydrofluoric acid burns, both rubber stoppers should be replaced and the cap securely hooked down before returning empties. When a carboy is received with a leak, it should be thoroughly washed inside and out before returning.

The names of makers of materials recommended may be obtained from the author at River Road, Camden, N. J.

River Road, Camden, N. J.

Training Course of the American Steel & Wire Company

By Chas. R. Sturdevant

Educational Director, A. S. & W. Co.

No arguments are needed in these days to show why salesmen or other men holding responsible positions should, in some manner, be given special training and be encouraged to become the very best of which they are capable. This principle has become so thoroughly recognized and so firmly established that to-day hundreds of our leading business and industrial concerns either have well established courses, or are casting about to discover some effective way of training those employees holding responsible positions.

With concerns housed in one building, or a single group of buildings, the problem is a comparatively simple one, for the men to be trained can be brought together once or twice a year, having them confer with the several department heads, listen to lectures, and make inspection trips through the mills. But when the mills are widely scattered, and when widely differing products are made in them, the problem becomes a difficult one.

The American Steel & Wire Company has mills and offices located at Chicago, Cleveland, Pittsburgh, Worcester and other cities. It employs many thousands of men and women, and makes a wide variety of wire products, both steel and copper. As the business expanded and the company grew, there developed an insistent need of some thorough, systematic method of training its employees in matters pertaining to the steel and wire business. Such a course was instituted in 1912, and it has met with such success that a description of the work will be of general interest.

As originally organized the course was intended for veteran salesmen only, but shortly afterwards it was found advisable to slightly modify the course and make it suitable for men from other departments as well. The course is intended only for employees who have been in our employ for a considerable period—not for beginners. It is carried on under the immediate supervision of three competent instructors taken from the organization, and requires practically all of their time. The class spends one week in the Pittsburgh district, three in the Cleveland district and two and one-half at Worcester, Mass. To complete the course thus requires six and one-half weeks of intensive study and application on the part of the men. All traveling expenses are paid by the company, and a daily allowance is made for living expenses while engaged in the course of study.

The work has been handled in successive classes of about twelve men each, and seven classes have taken the course each year. The twelve men constituting a class are purposely chosen from different parts of the United States, and from different departments. Ordinarily there will be about two men from the operating department, one from the accounting, one from the order department, and eight from the sales department. In general these men will differ widely in age, experience and capabilities. The close association, for six and one-half weeks, of such a diversified group of men, is in itself a liberal education.

The men selected for a given class are given two or three weeks' previous notice, and are, at the same time, assigned suitable preparatory reading matter. At the appointed time they assemble at Pittsburgh, Pa., where they will first meet an instructor who will organize them into a class, and who will remain their instructor and guide during the succeeding four weeks.

Nearly all of the first week is taken up in making inspection trips through various steel and wire mills in the Pittsburgh district. This affords the men an opportunity of obtaining a general idea of how all our products are made and of the work to be taken up in the course, and also stimulates a strong desire to go thoroughly into details.

During the second week the class studies steel making. From step to step they learn how the ore is converted into pig iron, how this is converted into the several grades of steel, and finally how the steel ingot is made into a rod. During the following week they are taught how the various grades and kinds of wire are made from rods. They become familiarized with our so-called "common products," and with the processes of manufacture. During the balance of the course they are shown and taught how this wire is given special treatments in order to impart desired properties; how the wire is tested, and how it is fabricated into the various common or special commodities made by the company, such as woven wire fencing, wire nails, wire rope, electrical wires and cables and so on.

The real work of the course, it will be observed, begins with the second week, after the men have become well acquainted with their fellows, and with the work to be covered. Each day's work from then on (except on Saturdays) is divided into four periods; a forenoon mill inspection trip, a noon-day lecture and discussion, an afternoon quiz and evening study.

Each morning the class, under the guidance of an instructor and one or two mill-foremen, is taken slowly through some one mill where they can witness every detail of the process involved in the making of some one product or some closely related group of products about which they studied the evening before. In this manner the men are given every opportunity of making a detailed study of all essential materials, processes and

mill equipments. This systematic method of making mill inspection trips is very much more effective than the old way of sending them alone into the mills to wander about aimlessly.

Just before or after the mid-day lunch, the mill superintendent or department expert will carefully review the morning's work, and afford the men an opportunity of asking questions and entering into a general discussion. During the latter part of each afternoon, an instructor subjects the members of the class to a searching quiz, which helps greatly to organize the knowledge of the day's work, and to fix it in their minds. This quiz also enables the instructor to determine very quickly the points which need to be especially emphasized, and it soon indicates to him the particular men who need personal help. It further gives each man an opportunity of measuring himself with others who have had the same opportunities, and it is a strong agency to spur him on to his best efforts.

At the close of the quiz, a small, specially prepared booklet is given to each man covering the following day's work, and the men are requested to study this thoroughly during the evening. It will be seen that the course is laid out on the budget system—a full day being devoted to some one subject, and the various subjects are of course taken up in logical order from day to day, proceeding naturally from the simple to the more complex.

On several occasions, the class is given regular set lectures by department heads. These are not only enjoyable diversions, but they serve to bring the whole personnel of the company into closer touch and sympathy.

Five written examinations are given, usually on Saturday mornings, and at the close of the course one whole day is devoted to a general oral review. These examinations are carefully reviewed and graded, and they help to make up the final report of each man, copies of which are sent to those of our company who are directly interested.

While it is an intensive course of study, the work has been so laid out and is so handled as to require a minimum amount of time and effort on the part of the student. And while a great majority of the men are wholly unused to study or to close application at the time they enter the course, in spite of these seeming handicaps, they do acquire a surprising amount of useful knowledge even in so short a period as six and one-half weeks.

As to the resulting benefits both to the men and to the company, there are many. Aside from the direct result of a greatly increased useful knowledge of the technique of the business, they learn to think straight in the conception and application of fundamentals; they are given a broadened viewpoint and a quickened interest in their work. This free exchange of views acquaints many for the first time with the difficulties which men in other departments have to overcome, and this encourages them to better team work and makes them less critical. The course stimulates self-confidence, loyalty and good fellowship. The one great regret of the older men who have taken this course is that they were not given the opportunity earlier in life, which, in itself, is ample justification of the effort put forward in their behalf.

Worcester, Mass.

On the Superheating of Slags and Metals During Refining, Smelting and Alloying Operations*

BY J. E. FLETCHER, M.I.MECH.E.†

In the production of wrought iron and steel or ingot iron in the open-hearth furnace, it is becoming clearer that the mechanism of refining and alloying is that of the intimate reactions which occur between the various constituents of the pig iron, ore, and scrap charged and those of the slags used in the efficient carrying out of such processes.

The finished cold cast products are crystalline composite masses made up of more or less carbonized or otherwise alloyed crystals separated from each other by boundaries which probably always contain minute particles or films of isolating matter. It is known that such films often contain the iron oxides FeO and Fe_2O_3 together with silicates of iron and manganese. There is further evidence that occluded gases in a fine state of division occur within the crystal boundaries. Such films must tend towards the non-welding of the adjacent crystal faces when the molten or liquido-plastic crystals are being drawn together in their passage to the solid state.

The high temperatures needed in the ferrous alloy processes make the study of the reactions and of the constitutional changes in both slags and alloys exceedingly difficult; there is a sense, however, in which it may be said that the reactions at high temperatures are more simple than at lower ones. Thus M. Charpy succeeded in cementing or carbonizing iron filings by heating at 650 deg. C. for about forty hours in potassium cyanide, the alloy produced being the iron carbon eutectic containing 4.3 per cent carbon and melting at about 1130 deg. to 1135 deg. C. Similarly after heating for eighty-five hours the alloy containing 6.67 per cent carbon and 93.33 per cent iron (Fe_3C) was produced. With only three hours' heating at 1130 deg. C. the 4.3 per cent carbon eutectic alloy resulted. Moissan, at the temperature of the electric arc, succeeded in carbonizing iron to a content of about 4 per cent in three minutes, and the author, in a like period, also at the temperature of the electric arc, obtained an alloy containing 5.5 per cent carbon. Later Ruff and Goecke produced a 9.6 per cent carbon iron alloy by cementation in an electric furnace at 2220 deg. C., the time required at this high temperature being relatively short. These experimenters concluded that there is a progressive formation of the carbides Fe_3C, Fe_2C, and FeC at increasing temperatures until at about 2700 deg. C. gasification of the alloy (FeC + Fe) takes place.

SLAGS IN GENERAL

The refining and alloying slags in iron and steel processes may be divided into three types, viz., those whose temperatures of formation, fusion, and equilibrium are (1) higher, (2) approximately the same, and (3) lower than the fusion and equilibrium of the metallic alloys in contact with the slags.

The slags of type one are representative of blast-furnace working, where the pig-iron fusion temperatures are in the neighborhood of 1140 deg. C. Such slags have the composition:

*A paper presented before the 1917 meeting of the Society of Chemical Industry, Birmingham, England.

†President, Staffordshire Iron and Steel Institute.

$CaO + MgO + FeO + MnO = 50$ to 55 per cent,
$SiO_2 + Al_2O_3 + P_2O_5 = 45$ to 50 per cent,

the fusion temperatures of which are in the region of 1400 deg. C.

The slags of type two are typical of the puddling process where the fusion and softening temperatures of the metal being operated upon vary from 1130 deg. to 1450 deg. C., the slags having fusion temperatures varying between 1080 deg. C. and 1350 deg. C. and are silicates of iron and manganese of the approximate analysis:

$FeO + Fe_2O_3 + MnO = 70$ to 80 per cent,
$SiO_2 = 20$ to 30 per cent.

The slags of type three are representative of the open-hearth steel melting processes. Here the metal fusion temperatures vary from 1130 deg. to 1500 deg. C., whilst the slags fuse at between 1100 deg. C. and 1350 deg. C. and have the typical analysis:

For the acid process:

$CaO + MgO + FeO + MnO = 40$ to 50 per cent.
$SiO_2 + Al_2O_3 = 50$ to 60 per cent.

For the basic process:

$CaO + MgO + FeO + MnO = 80$ to 70 per cent.
$SiO_2 + P_2O_5 = 20$ to 30 per cent.

Now obviously the temperatures of refining, smelting, and alloying hearths of the furnaces must be kept higher than those of the slags or metals under treatment. Hence in case one the blast-furnace metal is superheated above its fusion point; in case two the puddled iron and slags may be kept nearly at their proper fusion temperatures; and in case three the slags are superheated above their fusion temperatures.

BLAST-FURNACE SLAGS

Here the slag fusion temperature is higher than that of the contact metal. The temperatures of the tuyere zone are in the region of 1500 deg. C., the slag fusion temperatures being between 1350 deg. C. and 1450 deg. C., while the underlying metal is melted at roughly 1140 deg. C. The slag and metal are therefore continuously superheated above their fusion temperatures. The metal in the hearth is primarily of eutectic composition or thereabouts, viz., 4.3 per cent carbon, 95.7 per cent iron. The result of superheating this eutectic is first to render the contained carbide of iron (Fe_3C) unstable. The higher it is heated above its melting point, 1130 to 1135 deg. C., the greater is this instability apparent and its sensitiveness to refining or alloying action increased. Similarly the oxide constituents of the slag which are reducible at the hearth temperatures become unstable under conditions of superheat, the silica, SiO_2, and phosphate of lime, $4CaOP_2O_5$, being readily reducible.

At the hearth temperatures, 1500 deg. to 1600 deg. C., the slag composition tends to adjust itself by parting with SiO_2 and P_2O_5 until it attains equilibrium consistent with the degree of superheat. If given sufficient time at, say, 1500 deg. C., an equilibrium corresponding to the slag composition 20 per cent Al_2O_3, 80 per cent CaO·MgO would arrive in the case of a smelting using a working slag of primary non-superheated analysis 30 per cent SiO_2, 15 per cent Al_2O_3, 55 per cent CaO·MgO. The 1500 deg. C. saturated slag would then be inert, there being no further reducible constituent present in the slag. The metal in contact with the slag would also have moved toward stable equilibrium, and it can be shown that in the case of ferro-silicon manufacture an alloy of composition,

C	0.5%
Si	9.3%
Fe	90.2%

would result when the slag becomes inert. The fusion temperature of resulting slag and metal would be about 1450 deg. C. (In this case phosphorus, sulphur, and manganese have been omitted for the sake of simplicity.)

It is impossible at present to state the composition which corresponds to the stable equilibria of slags at varying temperatures or of the metallic alloys in contact therewith, but it may be inferred from the foregoing that by proper adjustment of the primary slag composition it is possible by correct temperature control to regulate the alloying actions in the metal.

It is clear that the cast iron becomes alloyed with silicon and phosphorus at the expense of its carbon the more readily as the slag is superheated and hence free to act on a superheated metal (unstable) in contact with it. Figure 1 illustrates the changes in the composition and temperature of equilibrium during the progressive alloying of a white iron with silicon. The active and relatively inert conditions of the slag are indicated by the shaded area marked "superheat." The higher the superheat the more active the slag and the more unstable the metalloid compounds in the metal attacked.

There are, doubtless, cases where, as in certain pneumatic refining and smelting processes, the excess of oxygen leads to oxidation of the metal underlying the slag. Such oxides may there rise to the surface and enter the slag which under certain temperature conditions may become more active, increasing the slag superheat because of the addition of iron oxide to the slag and coincidently lowering its fusion point. Carbon in a pig-iron charge may thus be oxidized at the expense of iron oxides FeO and Fe_2O_3 in the slag, iron passing back into the metal; such action being coincident with or preceding the silicon or phosphorus transfer. Thus a blast-furnace slag may become rich in FeO, the resulting pig iron being white. Iron has then been reduced from the slag in preference to silicon, and the total carbon content of the pig iron is lower than in the case where a normal slag free from FeO has been employed.

PUDDLING SLAGS

In the puddling process the slags are of the type ($FeO·Fe_2O_3·SiO_2$) having temperatures of fusion and

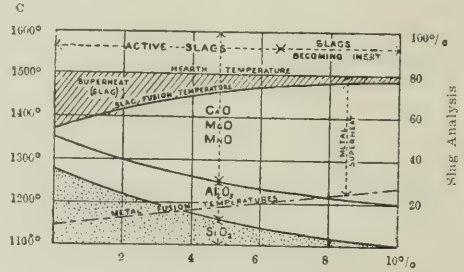


Fig. 1.
Equilibrium in Blast Furnace

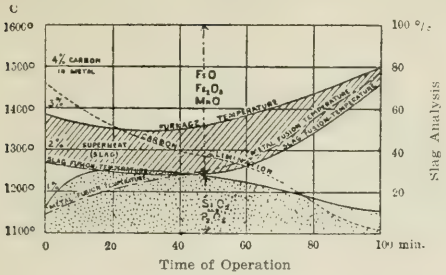


Fig. 2.

Equilibrium in Puddling Process

equilibrium not much different from those of the pig irons which it is desired to refine. Here it is necessary to desiliconize, dephosphorize, and decarburize the pig iron underlying or in contact with the slag. The initial fusion temperature of the pig iron to be refined is about 1140 deg. C., that of the first superposed slag being, say, 1260 deg. C. This slag is therefore superheated and consequently active. Unlike the blast-furnace slag the puddling slag is basic and continues so throughout the process. There is no deterrent or inert constituent such as lime or alumina, hence temperature variations rapidly alter the slag constituency. The active iron oxides in the slag attack the unstable iron phosphide and silicide in the pig iron and primarily furnish the oxide for gasifying the unstable carbon in the superheated iron carbon alloy, and for oxidizing the silicon and phosphorus which are also but feebly stable at temperatures above 1100 deg. C. There is an automatic adjustment of the slag composition throughout the process. At the beginning and end of the operation the temperatures are higher than during the intermediate stage. The initial and final slags are therefore high in $FeO \cdot Fe_2O_3$, and low in SiO_2, whereas in the intermediate stage the slag is more siliceous and more readily fusible. During "rash" or careless working the end of the operation is conducted at too high a temperature; hence the slag is too highly superheated and adjusts its composition by robbing the iron bath or sponge. The iron oxide thus added to the slag is largely the result of oxidation by the furnace gases (rich in O and CO_2). Figure 2 illustrates the foregoing actions. It is seen that the superheat is not so great as in the blast-furnace operation. Figure 3 shows the progress of refining and the coincident slag adjustment composition during the complete puddling process, and illustrates most clearly the effect of superheat on the slag and metal equilibria.

MANGANESE IN FURNACE SLAGS

In the production of certain alloy steel the effect of superheating the working slags results in the pronounced separating out of the most readily reduced slag constituent. Thus in the making of manganese steel in the open-hearth furnace the primary slag covering the molten pig-iron charge was a rich ferrous slag of the composition approximately $FeO \cdot Fe_2O_3 = 80$ per cent, $SiO_2 = 20$ per cent, fusible at about 1300 deg. C. Into this a pyrolusite ore of analysis

MnO_2	85%
CaO MgO	5%
SiO_2	10%

was gradually added. The MnO_2 becomes MnO on

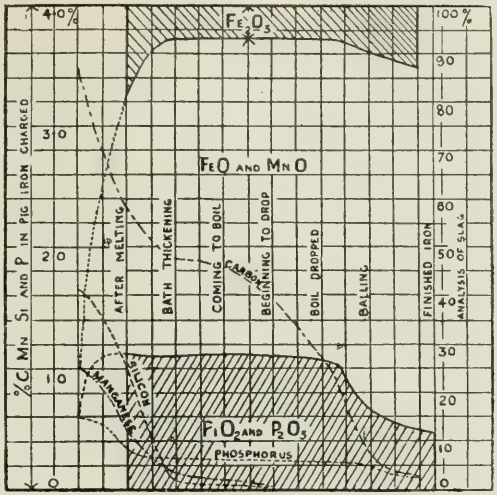


Fig. 3.

Effect of superheat on the slag and metal equilibria.

superheating, the FeO being changed to Fe_2O_3 by the oxygen liberated from the MnO_2. It was then found that the FeO and Fe_2O_3 in the slag, if increased by further additions of hematite ore (manganese) and lime, caused a rapid reduction of the manganese from the slag, manganese entering the liquid metal. When the slag contained over 50 per cent of manganese then that element entered the metal, whereas if the slag was adjusted so as to contain above 50 per cent of iron, then iron was reduced from the slag in preference to manganese. An increase in the superheat in either case increased the rapidity of the reduction. The temperature was not measured, but it was noticed that the slags higher in MnO were more fluid than the rich FeO-slags, and were apparently fusible at a lower temperature. Hence at the practically constant furnace temperature the high MnO-slags were more highly superheated than the high FeO-slags, hence more unstable, and then manganese in consequence more readily reduced.

The refining of alloys may be illustrated in the case of the elimination of manganese in the puddling or open-hearth steel processes. Thus the reaction between the slag constituent $FeO \cdot Fe_2O_3$ and the alloy constituent Mn_3C in the pig iron is of the type:

$$FeO \cdot Fe_2O_3 + Mn_3C = 3MnO + CO + 3Fe.$$

Manganous oxide displaces the iron oxides in the slag, the manganese in the pig iron being replaced by pure iron from the reduction of the iron oxides. Superheating the slag renders the $FeO \cdot Fe_2O_3$ more active, while that of the molten pig iron increases the instability of the Mn_3C. In the interaction CO gas is liberated. The slag is enriched by the entrance of MnO at the cost of the iron oxides $FeO \cdot Fe_2O_3$. Professor Turner's view that in such actions the active oxides $FeO \cdot Fe_2O_3$ are the reducing agents has been taken. They are in the state of least stability and hence in the condition to react with the other unstable compounds present when by superheat their stability is decreased. Possibly at the moment of exchange it is the ferrous oxide

which reacts with the Mn_3C in a reversible sense thus:

$$3FeO + Mn_3C \rightleftarrows 3MnO + Fe_3C.$$

Superheating the oxide FeO in an oxidizing atmosphere leads to the formation of Fe_2O_3 (as in the production of "bull-dog slag" by calcining puddling-furnace tap cinder). On the other hand, liquid Fe_2O_3 when in contact with molten iron-alloys is readily converted to FeO providing a reducing or neutral atmosphere is maintained in the working chamber.

ALLOYING A METALLIC MASS UNDERLYING A RICH SLAG

In siliconizing the white eutectic iron in the hearth of the blast furnace the SiO_2 in the slag interacts with the Fe_3C in the carburized white iron:

$$SiO_2 + 2Fe_3C = Fe_2Si + 4Fe + 2CO.$$

The carbide of iron in the eutectic metal is displaced by silicide of iron and pure iron is coincidently set free. CO gas is liberated and the slag is impoverished by the loss of the silica SiO_2. This exchange is affected by the superheating of the slag, the silicate of lime or magnesia therein becoming unstable. The interaction between the SiO_2 and the unstable superheated Fe_3C is thereby promoted as shown.

LIBERATION OF OCCLUDED GASES

When cast iron is heated considerably above its melting point the occluded gases, which are not inconsiderable in quantity, and consist mainly of CO and H, are set free. An examination of the microstructure of a pig iron which has been thus heated toward its boiling point reveals particles of silica surounded by an envelope of ferrite together with flakes of coarse graphite. It would appear that a reaction has taken place in this case between the escaping CO gas and the silicide of iron Fe_2Si, thus:

$$Fe_2Si + 2CO = SiO_2 + 2Fe + 2C.$$

The slaggy particles appearing in the microstructure are probably a silicate of iron formed according to the reaction:

$$Fe_2Si + 3CO = 2FeO{\cdot}SiO_2 + 3C.$$

In some cases such silicate slag rises to the surface of the metal which has been desiliconized to some extent by gaseous means. Again, sometimes iron oxide particles occur mechanically mixed and distributed throughout the cast-iron or steel mass as a result of over-oxidation or over-blowing in the hearth or bath of the furnace or converter. The effect of superheating such an alloy is to further refine the metal thus:

$$FeO{\cdot}Fe_2O_3 + 2Fe_2Si = 2SiO_2 + 7Fe,$$

$$\text{or } FeO{\cdot}Fe_2O_3 + Fe_2Si = 2FeO{\cdot}SiO_2 + 3Fe,$$

$$\text{and } FeO{\cdot}Fe_2O_3 + 4Fe_3C = 15Fe + 4CO.$$

H. Brearley has illustrated this action in his book on case-hardening, where a slag globule is shown surrounded by a ferrite envelope, and generally in iron and steel slag streaks are associated with adjacent ferrite.

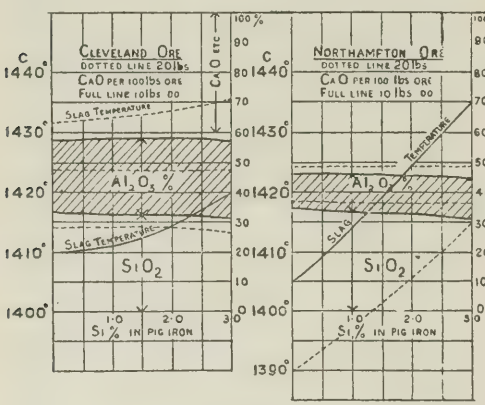


Fig. 4.

Automatic adjustment of a typical blast furnace slag.

MECHANISM OF REFINING

The mechanism of refining and alloying through the offices of the slags is shown in Tables I and II. In the blast furnace a portion of the carbon in the carbide Fe_3C is liberated in the CO gas formed and pure iron is freed to unite with the Si and P as silicide of iron Fe_2Si and phosphide of iron Fe_3P. These actions occur when the slag is superheated.

The automatic adjustment of a typical blast-furnace slag is shown in Figure 4, where, during the alloying of the iron in the blast-furnace hearth with silicon (the resulting pig irons having 0 to 3.0 per cent silicon) the slag composition alters thus:

	SiO_2	Al_2O_3	CaO MgO	Slag Softening Temp.
	Per Cent	Per Cent	Per Cent	Deg. C
Before alloying with Si.....	28.5	20.7	47.1	1435
With 1% Si in pig-iron.....	28.1	21.5	48.9	1440
With 2% Si in pig-iron.....	27.5	21.7	49.7	1440
With 3% Si in pig-iron.....	26.5	22.2	50.3	1445

As the slag adjusts itself during the loss of silicon the fusion temperatures of the slag are raised. Hence a higher hearth temperature and resulting slag and metal superheat become necessary as the more highly silicious pig irons are made.

Table 2 illustrates the mechanism of refining action in cupola, open-hearth, and puddling operations. Here the pig iron being refined is superheated above its melting point, the silicide, phosphide, and carbide of iron being thereby rendered unstable and react with the similarly unstable slag oxides (in this case the iron oxides). Silica and phosphoric acid escape to the slag and CO gas is liberated. The iron set free by the decomposition of the silicide, phosphide and carbide of iron and that added by deposition from the slag oxides, together with the primary iron crystals in the original pig iron (if containing less than 4.3 per cent carbon), yields a refined product more or less free from silicon, phosphorus, manganese and carbon.

IMPORTANCE OF SLAG-METAL CONTACT

It is evident from the foregoing that intimate contact between the metals and the slags in smelting, refining, and alloying operations is imperative if successful results are to follow.

In the blast furnace the reduction of the ores must be largely through gaseous (CO) influence. It is not possible for sufficiently uniform carbon (coke) contact with the oxide of iron (Fe_2O_3, etc.) particles to take place. The slag blanket which covers the metal in the hearth of the furnace is agitated by the splashing and penetration of the drops of liquid metal and slag as they descend from the upper portions of the tuyere

TABLE 1—BLAST FURNACE ALLOYING REACTIONS

	SUPERHEATED UNSTABLE CONSTITUENTS				RESULTING ALLOYS IN METALS				CONSTITUENT EJECTED FROM METAL	
	In Slag	Lbs.	In Metal	Lbs.	Compound	Lbs.	Free	Lbs.	Compound	Lbs.
A.....	SiO_2	60	Fe_3C	340	Fe_2Si	140	Fe	224	CO	56
B.....	P_2O_5	142	Fe_3C	900	Fe_3P	398	Fe	504	CO	140
C.....	MnO (1)	213	Fe_3C	180	Mn_3C	177	—	—	FeO	216
D.....	FeO(2)	216	C	36	—	—	Fe	168	CO	84
					Reactions					
A.....	SiO_2	+	$2Fe_3C$	=	Fe_2Si	+	4Fe	+	2CO	—
B.....	P_2O_5	+	$5Fe_3C$	=	$2Fe_3P$	+	9Fe	+	5CO	—
C.....	MnO	+	Fe_3C	=	Mn_3C_2	—	—	+	3FeO	—
D.....	3FeO	+	3C	=	—	—	3Fe	+	3CO	—

TABLE 2—OPEN-HEARTH, PUDDLING AND CUPOLA REFINING REACTIONS

	SUPERHEATED UNSTABLE CONSTITUENTS				RESULT OF REFINING NEW CONSTITUENTS ADDED				COMPOUND EJECTED	
	In Slag	Lbs.	In Metal	Lbs.	To Slag	Lbs.	To Metal	Lbs.	Compound	Lbs.
A.....	$FeO.Fe_2O_3$	232	Fe_2Si	280	SiO_2	120	Fe	392	—	—
B.....	$FeO.Fe_2O_3$	322	Mn_3C	177	MnO	213	Fe	168	CO	28
C.....	$FeO.Fe_2O_3$	464	Fe_3P	398	P_2O_5	42	Fe	504	—	—
					FeO	216				
					Reactions					
A.....	$FeO.Fe_2O_3$	+	$2Fe_2Si$	=	SiO_2	+	7Fe	—	—	—
B.....	$FeO.Fe_2O_3$	+	Mn_3C	=	3MnO	+	3Fe	+	CO	—
C.....	$2FeO.Fe_2O_3$	+	$2Fe_3P$	=	P_2O_5	+	9Fe	+	3FeO	—

zone. Hence there is a greater contact between slag and liquid metal than at first appears. The relationship between the area of slag contact and the iron smelted per hour is of practical importance. The ratio

$$\frac{\text{area of slag contact (sq. ft.)}}{\text{iron smelted per hour (tons)}}$$

is 15 to 25 in the case of modern hot-blast furnaces. In the days of cold-blast furnaces the ratio was as high as 40 sq. ft. of slag contact per ton of iron smelted per hour.

In the foundry cupola the ratio for modern furnaces is 0.7 to 1.0 sq. ft. per ton of iron melted per hour, and in the open-hearth steel-melting furnace the ratio

$$\frac{\text{area of slag contact}}{\text{metal refined per hour}}$$

is 20 to 30. In modern rapid practice in large furnaces the ratio is tending to increase, shallow baths and large area of slag contact being necessary for intensive outputs.

The more viscous and light the slag is the greater is the need for large contact area. During mechanical or natural agitation the heavier slags penetrate the metal surface in direct proportion to their density. In the heavy yet mobile puddling slags the rapidity of the refining action is readily explainable and the low viscosity combined with the continuous hand or mechanical rabbling promotes better contact between the metal and oxide particles.

It can be shown that in the alloying of silicon with iron through contact of the carbide of iron with the silica of the slag in the blast-furnace process the relative surfaces of contact of these two constituents are as 1:1.26 approximately, whereas in the decomposition of Fe_2Si in the refining operation of puddling the ratio of contact areas between Fe_2Si and the oxides $FeO\ Fe_2O_3$ is as 1:1. Hence it follows that more homogeneous interactions occur in the latter process. It is interesting to note that the ratio

$$\frac{\text{area of slag contact (sq. ft.)}}{\text{metal refined per hour (tons)}}$$

is about 50, twice that of the open-hearth steel process, the area of contact being sufficiently large to enable efficient washing and rabbling of the metal and slag to be carried out.

THE LIQUID CRYSTAL PHASE

Dr. Desch, in his recent invaluable contribution to the Institute of Metals, drew attention to the possible existence of a liquid crystal phase at temperatures higher than the fusion point of metallic alloys. In the study of ferrous alloys the observed variations in the viscosity of hyper-eutectic alloys when heated above their melting points, the decomposition of the carbide or carbides in carbon iron alloys as influenced by the presence of silicon, phosphorus, etc., resulting in a graphite-bearing viscous state, and the micro examination of such alloys when quenched from the superheated condition, all strengthen the view that above the liquidus curve of the phase diagram there may be a liquid crystal phase. It is difficult to determine such a phase and its temperature limits, but there is much to suggest that liquid iron crystals more or less carbonized and siliconized in ordinary cast irons and steels do exist, and that their carbonization and siliconization are effected more rapidly as the temperatures approach the purely liquid phase.

Taking the fusion points of iron and iron carbide Fe_3C as 1500 deg. C. and 1850 deg. C. respectively, it might be found that a line drawn between the two (possibly not a straight line, but a drooping curve) would be the frontier line between the purely liquid and the liquid crystal phases. In such a case the primary nuclei for crystal growth would occur within the liquid crystal phase and would not depend upon the freezing action in the now recognized solidus phase. Thus graphite may be precipitated in the liquid phase and act as the nucleus for the primary liquid crystals. Similarly silico-ferrite crystals may commence to form from the same or a higher temperature in the liquid phase and start a secondary ferrite liquid crystallization.

It is in such considerations that the difference between crucible melting (in a furnace with walls superheated above the temperature of the liquid crystal phase) and cold-hearth melting appears. Just as the steam bubbles in a boiler rise most strongly from the zones next to the heating surfaces, so the occluded gases and convection currents within a molten metal in a crucible rise most powerfully from the zones next to the heated walls. These details may have much to do with the fineness of crystalline structure in the final cast metal and with the homogeneity or heterogeneity of such structure. The fineness of such structure is related to the crystal boundary question, and to the freedom from gaseous or refining oxide and slaggy inclusions within such boundaries.

APPLICATION TO REFINING

It is instructive in this connection to trace the successive series of iron (liquid crystalline) deposition in the refining processes. In Table 3 the possible order of iron crystalline deposition is shown in three well-known variations of the open-hearth steel-making processes.

The first stage of the operation in each case is that of melting the charge. In the liquid thus formed are the primary crystals (melted or as liquid crystals) originally present in the pig-iron or steel scrap. The next iron addition to the bath is due to the decomposition of Fe_2Si, the Si entering the slag and liberating the iron of the silicide, coincidently there being added to the liquid mass free iron reduced from the iron oxides of the slag. Manganese carbide is next attacked by the slag oxides and MnO enters the slag, being displaced by pure iron reduced from the iron oxides in the slag. After this comes the carbon elimination, the carbide Fe_3C on decomposition yielding its Fe to the bath and simultaneously adding pure iron reduced from the iron oxides in the slag. Finally when iron ore (Fe_2O_3) in excess of purely refining requirements is added to the slag, further iron is reduced and makes the final contribution to the mass of refined metal. The analyses and estimates given in the table are only approximate, but are believed to offer a comparative view of the order of iron crystallization during refining in the three types of steel-making. Whether the iron increments are actually liquid crystals is as yet open to question.

Table 3

Analyses of Materials	C	Si	Mn	Fe	Fe_2O_3	SiO_2	S & P
	%	%	%	%	%	%	
Pig iron	3.8	1.5	0.8	93.9	–	–	Not estimated
Steel scrap	0.2	0.1	0.7	99.0	–	–	–
Ore	–	–	–	–	60 6	10.0	–

Pig and ore process—charge 75% pig, 25% ore.

(1) Primary crystals in pig iron = 30.5 initially present in pig iron
(2) Iron crystals from Fe_2Si decomposition = 4.3 refining of silico-ferrite.
Iron crystals from slag reduction = 3.3 refining of silico-ferrite
(3) Iron crystals from Mn_3C decomposition = 0.7 refining of eutectic
(4) Iron crystals from Fe_3C decomposition = 40.0 refining of eutectic
Iron crystals from slag reduction = 9.6 refining of eutectic.
(5) Iron crystals from ore reduction = 11.6 alloying by iron reduced from ore

Pig and scrap process—charge 50% pig, 50% steel scrap.

	Per Cent
(1) Primary crystals in pig iron	= 18.5
(2) Primary crystals in scrap iron	= 44.0
(3) Crystals from Fe_2Si decomposition	= 2.9
Crystals from slag reduction	= 1.9
(4) Crystals from Mn_3C decomposition	= 1.1
(5) Crystals from Fe_3C decomposition	= 25.6
Crystals from slag reduction	= 6.0

Pig, scrap and ore process—charge [illegible]% of each.

	Per Cent
(1) Primary crystals in pig iron	= 14.6
(2) Primary crystals in scrap iron	= 34.5
(3) Crystals from Fe_2Si decomposition	= 2.4
Crystals from slag reduction	= 1.6
(4) Crystals from Mn_3C decomposition	= 0.8
(5) Crystals from Fe_3C decomposition	= 20.0
Crystals from slag reduction	= 4.9
(6) Crystals from ore refining	= 20.2

REFINED IRON STRUCTURES AND SUPERHEATING CONDITIONS

In the United States Mr. J. E. Johnson, Jr., the well-known blast-furnace expert, has produced a cast-iron which approximates in character to the finest of charcoal cold-blast iron such as is made in Sweden.

By adding a cast iron which has been partly refined in a Bessemer converter to an ordinary foundry iron molten from the blast furnace the following actions occur: The bessemerized metal low in carbon content and containing considerable quantities of occluded gases and oxide particles is much higher in temperature than the blast-furnace metal to which it is added. The superheating action on the latter metal subjects the unstable carbon and silicon as carbide and silicide of iron to a secondary refining action. Some of the graphite is probably oxidized, and iron oxide from the Bessemer metal becomes reduced within the mass. The result is a lower-carbon iron with smaller nuclei of graphite than is found in hot-blast pig irons.

SLOW VS. RAPID REFINING

The relative action of slow and rapid refining as typified in the production of practically carbonless iron in the puddling and open-hearth furnaces is well illustrated in the two micro-photographs, Figures 5 and 6 (100 diameters). Here the same raw materials were used in the open-hearth and puddling operations, the resulting refined irons being of similar analysis. The two irons were similarly reheated, piled and rolled. The difference in the size of the ferrite crystals is very pronounced, the puddled iron having much the coarser structure. The open-hearth iron, melted and refined

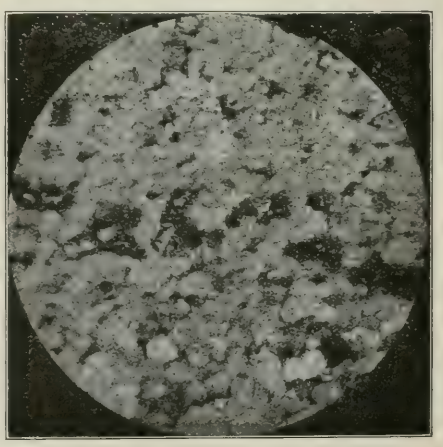


Fig. 5.
Open-hearth iron.

Fig. 6.
Puddled iron.

under high superheat conditions, unassisted by artificial rabbling and agitation, has a finer crystallization than the puddled iron, which is refined at lower temperatures. This latter action, carried out in a hearth which is itself composed of active reducing oxides, must obviously tend to a coalescence and welding of adjacent iron grains or crystals which is impossible in a bath where the refining action proceeds by way of contact only with a superincumbent slag of low specific gravity and high visocity. It goes without saying that the question of crystalline metallic structure is inseparably connected with the slag functions. Micrographic analysis cannot reveal the true character of the boundary films, the process of polishing the slag inclusions being altogether unsatisfactory when it is desired to reveal the characteristic structures at high powers of magnification. It would appear, therefore, to be of increasing importance to study the crystalline boundary problem in the light of the foregoing conclusions, bearing in mind the facts that the crystals or crystallites begin to grow in a liquid carrying oxides, slaggy, gaseous or metallic.

These oxides, during their own decomposition, may form secondary crystals, or, in their passage to the slag covering, become entrapped as films within the contracting crystal boundaries.

New Bureau of Mines Stations

Secretary of the Interior Lane, in a recent departmental order, authorized the establishment of a mining experiment station at Columbus, Ohio, under the jurisdiction of the Bureau of Mines, the station to represent the ceramic industry of the United States. Columbus was selected as the site for the station because it is the capital of the state recognized as the center of the clay working and allied industries and also because the Bureau can work in cooperation with the School of Ceramics at Ohio State University. A station has also been authorized at Minneapolis, Minn., to represent the iron mining districts and to work in co-operation with the School of Mines of the University of Minnesota.

Refractory Magnesia

By R. C. Gosrow

The Eighteenth Ordinary meeting of the Faraday Society held in London, England, on Nov. 8, 1916, when a general discussion was held on refractory materials, brings to the attention of the metallurgical world, once more the need of more work and reliable data on refractories for high temperatures.

Having been directly interested in and working with magnesia as a refractory for several years past, my attention was drawn to the abstracts of the papers presented at the above meeting as given in Metallurgical and Chemical Engineering of Dec. 15, 1916.

In the articles cited, Dr. R. S. Hutton of Sheffield made the plea for more work on the refractories that are used at the temperature of the electric furnace. He also mentioned the properties of completely shrunk magnesia as being quite different from ordinary calcined magnesia, and also that the shrinking could be economically effected electrically. It might be of value here to give an account and some data from my own experiences in the calcining of magnesite and the electrical dead burning and shrinking of the magnesia so formed.

The magnesite which was used was from a deposit in lower California, from which considerable quantities of magnesite had been mined and shipped in previous years.

The raw magnesite analyzed:

Insoluble	0.50 per cent
Al_2O_3 } Fe_2O_3 }	0.90
$CaCO_3$	Traces
$MgCO_3$	98.10 per cent

This was a massive magnesite, white in color, and having a hard conchoidal fracture.

The raw calcining was carried on in a vertical kiln 30 in. inside diameter and 5 ft. deep. This was so arranged that a door on one quadrant near the bottom allowed the calcined material to be drawn out, and at 90 deg. with the draw hole was an opening 10 in. by 12 in. for a pressure air-oil burner. The burner was 15 in. from the bottom of the shaft. Lumps of magnesite 1½ in. to 3 in. were charged in such a way that the interstitial spaces between the lumps were not filled up, but allowed the gases to escape at the top of the kiln. The kiln was two-thirds filled, and firing started. As the top of this became hot, the kiln was slowly filled to its full holding capacity, the top always reaching a dull yellow heat before more magnesite was added. The kiln held bout 1200 lb. of raw rock. This was fired for 10 to 12 hours, when the whole mass was a bright yellow. The oil burner was shut off and this opening plugged tight. The top was covered and the kiln allowed to cool slowly overnight. The walls of the kiln were thin, to allow the mass to radiate its heat sufficiently fast to handle the material in the morning. The kiln content was drawn out on a flat sheet-steel plate and sampled. The analysis was:

Ignition loss	2.20 per cent
Fe_2O_3 and Al_2O_3	1.90
MgO	94.70
CaO	0.10
Insoluble	.85
	99.75

The magnesite lumps which occupied about three-fourths of the kiln's height, were burned to buff-colored clinkers, and showed no core in the 3-in. lumps, but fell apart easily with handling during the drawing and sampling. That portion which occupied the upper one-quarter of the kiln was not clinkered well and was powdery and white. But owing to the subsequent treatment of this calcined material, it was immaterial, regarding this fine soft material on top. The kiln was run on the described schedule until about 3600 lb. of magnesia was obtained. This magnesia was crushed to about ¼-in. size, and some unavoidably went to powder, and the whole then was divided up in 600-lb. lots.

These batches were then charged—600 lb. at a time—into the crucible of a 1-ton Stassano, 3-phase, arc-radiated steel furnace. The material was levelled up, and a current of 600-800 amperes carried at 150 volts for thirty minutes. During this time the magnesia was turned and rabbled to give it exposure to the flaming arc. Directly under the arc some magnesia fused to a hard slab, about 8 in. to 10 in. in rough diameter and about 1 in. thick. This was broken up and added along with the balance of the calcined material. Before charging each batch the furnace crucible was brought up to a bright yellow so that the furnace was hot when the material was charged into it.

The total amount of material charged in weighed 3600 lb. and the power consumption was 520 kw.-hr., metered on the secondary of the transformers. At 1c. per kw.-hr. the cost was $5.20, or a cost per 100 pounds of 14.4c.

The sampling was made on the cold material and showed 0.7 per cent loss on ignition by heating in an electric combustion tube furnace. The magnesia grains were hard and flinty, and scratched glass. They showed a specific gravity of 3.65.

A sample of ¼-in. lumps from this electrically burned lot showed no change in weight in moist air for ten days. Another sample, from the oil-fired kiln, previous to electrical burning, showed the following per cent increase in weight:

30 hours	2.5 per cent
44 hours	3.25 per cent
76 hours	3.70 per cent
100 hours	4.60 per cent
125 hours	5.25 per cent
150 hours	5.60 per cent
172 hours	6.00 per cent

The purpose of carrying on the work on magnesite and magnesia was to prepare a satisfactory dead burned and shrunk magnesia that would be suitable for lining the hearth and walls of an electric steel furnace.

The result desired was a monolithic lining, including side walls and hearth. In order to provide against any subsequent cracking or shrinkage it was considered essential to first take out all the shrink from the raw material, before setting in the furnace.

It may be of interest and value to give here the results of the first monolithic lining which was put in. The work was partially a success, and partially a failure. Both results may interest someone. The electrically burned magnesia was ground to about 6 mesh and thoroughly mixed with 10 per cent of powdered ferric oxide (80 mesh) and 5 per cent of a basic steel furnace slag. This mixture, approximating 4200 lbs. in weight, was heated in 1000 lb. batches, on a steel-plate frame, and well-boiled tar, to about 12 per cent, thoroughly mixed and heated with the basic materials. The mixture was rabbled well to insure coating of the grains with the hot tar.

The hot mix was then rammed in the side walls of the furnace, and around a steel-plate form, for the crucible. The side walls were 10 in. thick at the bottom and 7 in. thick at the top and 42 in. high. Steel hand rammers were used, and only small layers put in at a time, but constantly, and rammed hard. When the lining was completed the inner steel form was removed, and the inner surface smoothed up. The hearth in the furnace was put in on the old bottom. The roof was then replaced.

Before firing, the material was given 3 hours to air-set, and then an oil burner was set in the tapping-spout opening. The charging doors were opened and the oil burner lighted. A very small smoky flame was used, and eventually, as the walls became heated, distillation of the tar in the binder took place. Eventually the volatile gases burned and the excess tar was burned out, leaving principally a carbon residue between the grains of the material. It was given about 4 hours for the "smoking" and burning of the tar to take place. Gradually the heat from the burner was increased, until in about 8 hours the furnace was a bright yellow. The lining showed one small crack directly opposite the oil-burner flame, in a vertical position. The lining was extremely hard, and gave a metallic ring when hit with a steel bar.

At the end of 8 hours on oil firing, the electrodes were put in and the arc formed. (The furnace was a one-ton Stassano, radiated arc.) The heating took place evenly and without any further cracking developing in the lining. The walls and hearth were a bright yellow, and cold scrap was charged for a wash heat. About 1200 lb. was charged, and melting proceeded rapidly.

During melting, it was observed that directly over the electrode ports the magnesia mixture was falling down and accumulating on the electrodes. Eventually enough material fell onto the electrodes to cause a bridging across from one side of the port to the other, a distance of 5 inches. This material was white hot. When the last of the 1200-lb. charge was poured from the furnace, the furnace interior was a dazzling white. The lining was apparently in good shape so far as cracking or shrinking was concerned. But a considerable "sluffing-off" effect was noticed by an accumulation of material at the base of the walls, on the hearth. The lining was a dazzling white, and the arc was almost "out." The electrodes were brought nearer together, and a short arc could only be maintained. When the furnace-charging doors were opened large quantities of small floating particles of white substance floated through the air, coming from the furnace openings. These small particles in the air gradually spread out into feathery particles. This material was analyzed and showed magnesia to be the main ingredient, with some silica.

The "sluffing-off" effect became so great, that the hearth was covered with the material of the lining and the lining was now only about 4½ in. thick on the walls above where the slag line would be. Considering the uncertainty of this lining it was decided to repair the furnace with bricks and get back to producing steel castings and not holding up business with experiments.

The experiment showed several things, which have since then been useful in putting in monolithic linings of magnesia for ferro alloy furnaces:

1—After cleaning out some of the highly heated material, it showed considerable ferrous oxide, and a honeycombed structure which resembled incipient fusion and decrease in volume.

2—It was considered the mix was too high in iron oxide.

3—Hand ramming is difficult to give uniform density on so great a volume of material. Air rammers would be more desirable.

4—The lining walls were too thick, not allowing the effect of the heat to penetrate rapidly enough to burn and frit the whole wall. The inner wall was burned hard, but halfway through the material had no bond, and was very destructible and friable, which was evidenced by the "sluffing" effect.

5—Precautions are necessary to make hard and dense the material over openings, so this material doesn't sluff and fall down on the electrodes, short circuiting the current through the lining.

6—Rapid heating after burning out the tar and rapid heating to a maximum temperature appeared essential.

7—The desirability of using other binders than tar.

8—Futility of carrying on an experiment in apparatus for plant operations and interfering with plant output.

These results are given to show some causes of failure in monolithic linings.

In the past two years the writer has had considerable success in the application of monolithic basic linings, for ferro alloy furnaces, and other basic smelting processes, on tungsten, molybdenum and manganese.

Milwaukee, Wisc.

Concrete Ships.—The following extract taken from a letter from the Construcciones y Pavimentos, Barcelona, Spain, should prove very interesting:

"You know that is actually a very interesting question, as much in Europe as in America, the construction of reinforced concrete ships, being as they are more economical and of easier and more rapid construction than those of iron or timber.

"The only fault we can appoint about the reinforced concrete ship hulls, is their fragility at a clash. But we have the honor of informing you that Mr. J. Capmany, engineer chief of our reinforced concrete section has presented a letter of mark about a disposition by which this fault is, in a very simple manner, put aside, avoiding, in what the practice limits do permit it, the production of slits, making by this reason the reinforced concrete ships as sure for the navigation, at least, as those of iron.

"As we believe this notice will surely be interesting for the readers of your review, we have the greatest pleasure in putting it on your knowledge."

Nitrogen Fixation in Germany.—The production of ammonia in Germany by the Haber synthetic process, according to the *Frankfurter Zeitung*, rose from 30,000 tons in 1913 to 60,000 tons in 1914, 150,000 tons in 1915, and 300,000 tons (estimated) in 1916. An output of 500,000 tons of ammonia is anticipated in 1917, containing 100,000 tons of nitrogen; at the same time 700,000 tons of sulphate of ammonia (140,000 tons of nitrogen), and 400,000 tons of calcium nitrate (80,000 tons of nitrogen) are expected to be produced, the total including 320,000 tons of nitrogen, which exceeds by 100,000 tons the entire consumption of nitrogen in Germany in 1913.

A Scientist Officers' Reserve Corps

By Guy Y. Williams
Professor of Physical Chemistry, University of Oklahoma

President Stieglitz's proffer of the services of the members of the American Chemical Society to our Government in case of war and its grateful acknowledgment by President Wilson indicates that the services of our chemists will be used in helping our country win the present war.

European experience has shown that the war is largely a conflict between men of science. It is largely a war of chemistry and engineering. The various governments are employing their men of science in devising means of offense and defense. Problems of such unusual character arise that the most highly trained scientists and technicians are required for their immediate solution. Not only are chemists and other scientists acting as advisers to their governments but they are in the factories and upon the battle-field. University laboratories have been turned into small factories for the production of medicines, and analytical work on munitions and other supplies is now being done in a great many college laboratories. Students physically unfit for field service are usefully employed, under the direction of their professors, for the production of supplies.

The Germans used the poisonous gases produced by their chemists. The English and the French sent their chemists upon the battle-fields and into the trenches to combat chemistry with chemistry. The Universities, technical schools, and the chemical societies furnished this new army unit.

English experience[1] has shown that any government in time of war should have such an organization of professional chemists, so that the many requirements of the navy, the army and the aviation forces can be promptly and efficiently met. In addition to the great men of science acting for the most part in advisory capacities, it is necessary that chemists should control the manufacture of munitions, explosives, foods, drugs, metals, paper, rubber, oils, gases, etc. Chemists are required for analytical work and research. Chemists are used at the front to handle water supplies, to detect poisons in streams, to inspect, analyze and pass upon the soldiers' rations, to dispose of sewage and to assist generally in camp hygiene and sanitation.

That we are profiting by the experience of our French and English allies is shown by the following facts:

1. The Council of National Defense, through the Bureau of Mines in co-operation with the American Chemical Society, has prepared a roster of the chemists of the United States. Similar rosters of technically trained men are being prepared in all other scientific branches. Lists of seniors, majoring in scientific and technical subjects and in the foreign languages, have been requested of the universities by our government.

2. The recently organized Intercollegiate Intelligence Bureau has done a much needed work. Through state directors and their adjutants, it has collected data from the various universities and colleges with regard to the fitness of their students and alumnae for government service in the present war and possibly in subsequent wars. The collected data will enable the government to fill vacancies in offices, plants, factories, and the industries, and to put the trench chemist upon the battle-

[1]Chemistry in Wartime, Richard B. Pilcher. Proceedings of the Institute of Chemistry (1917).

field in a shorter time than it would otherwise be possible.

3. Advisory boards of the different branches of science have placed themselves at the command of the government to suggest lines of research and to aid in the conservation of our resources.

But will this give our government the kind of an organization that can be handled immediately and to the best advantage? From the point of view of a chemist and a former officer in the National Guard, I fear that it will not.

A scientist officers' reserve corps created upon about the same basis as the engineer officers' reserve corps would aid our government to as great an extent as any other officers' reserve corps. Let us have a group of scientific men who know something about military discipline, who realize the importance of time in military operations, and who are ready to report at once to any place designated by a war department order. Let us require of these officers certain educational qualifications, or their equivalent in practical work, in their particular fields. The English chemists who were in the teaching profession are now used as war chemists. Why not educate the American chemistry teacher, so that he can step out of the class room into the industries and immediately take up some line of work that would add to our country's munitions and food supplies?

A great many of our theoretical chemists and a greater number of our teachers of chemistry know very little about commercial chemical processes. Many of our chemists would grasp the opportunity to make a study of our commercial plants and processes, if they could be furnished with the means to do so. If a teacher of chemistry were an officer in the chemists' section of the scientist officers' reserve corps, and were required to spend 30 days each year studying commercial processes, on the same pay and allowances of regular army officers of equal rank, it would not be long until our government would have a large group of chemists well trained for public service, and our schools would profit from the contact of their instructors with actual plant and factory methods.

In Oklahoma, for example, a chemist reserve officer might spend one summer in the petroleum industries, another summer in the zinc smelters, and still a third summer in the glass factories. He might be ordered East for a summer's work in a munitions plant or required to work at nitrogen fixation processes until he is an expert in this one line only. Many chemists would be glad to give their services to the government in case of need, and those in the teaching profession could be made proficient in one industrial line if a plan as generally outlined above and as specifically outlined below were put into operation by our government.

I have carefully read that part of General Orders No. 32, War Department, July 28, 1916, that deals with the officers' reserve corps and have come to the conclusion that a scientist officers' reserve corps is not only possible, but that it is as necessary as any other branch of the officers' reserve corps. The following outline of the organization of the scientist officers' reserve corps conforms in general to that outlined for other corps. It is different only in that it establishes a new branch of the officers' reserve corps with duties specifically different from those of any present branch. There is a great deal of certain parts of G. O. 32 that fits the plan exactly, hence the wording is practically the same as that of this order and certain portions are quoted verbatim.

Section 37 of this order modified for our purposes should read:

The Scientist Officers' Reserve Corps.—For the purpose of securing a reserve of officers available for service as scientists temporarily in the service of the government, there shall be organized, under such rules as the President may prescribe, a scientist officers' reserve corps. Said corps shall consist of men selected from the various branches of science, and shall be divided into sections corresponding to the different branches of science. Except as otherwise herein provided, a member of the scientist officers' reserve corps shall not be subject to call for service in time of peace, and shall not without his consent, be called in a lower grade than that held by him in the said reserve corps.

The President, alone, shall be authorized to appoint and commission as reserve officers in the various sections of the scientist officers' reserve corps, in all grades up to and including the rank of major, such citizens as, upon examination prescribed by the President, shall be found to be physically, mentally, and morally qualified to hold such commissions. The proportion of officers in any section of the scientist officers' reserve corps and the total number in the corps shall be determined by the President.

Appointments for this corps shall not be dependent upon age, but shall be dependent upon educational qualifications, experience and special fitness for this service. When honorably discharged from the services of the United States, the scientist officer shall be entitled to retain his official title and, on occasion of ceremony, to wear the uniform of the highest grade he shall have held in the officers' reserve corps.

The Secretary of War, in times of peace, may order officers of the scientist officers' reserve corps, with their consent, to active duty in the services of the United States in such number as the public interests may require and the funds appropriated permit, and may relieve them from duty when their services are no longer necessary. While on such duty, they shall receive the pay and allowances, including pay for periods of sickness and leaves of absence, of officers of corresponding rank and length of active service in the regular army.

The commissions of all officers of the scientist officers' reserve corps shall be in force for a period of five years unless sooner terminated in the discretion of the President. Such officers may be recommissioned, either in the same or higher grades, for successive periods of five years, subject to such examinations or qualifications as the President may prescribe: Provided, that officers of the scientist officers' reserve corps shall have rank therein according to grades and length of service in the grades.

Section 38 of G. O. No. 32, W. D., 1916, somewhat modified, follows:

The Scientist Officers' Reserve Corps in War.—In times of actual or threatened hostilities the President may order officers of the scientist officers' reserve corps to temporary duty in any plant, factory, or industry that is producing supplies needed by the Government in prosecution of the threatened or actual war. While such reserve officers are in such service, they shall by virtue of their commissions exercise command appropriate to their rank, or in such a manner as the President may prescribe, and shall be entitled to the pay and allowances of the corresponding grades in the regular army with increase of pay for length of active service, as allowed by law for the officers of the regular army, from the date upon which they be required, by the terms of their orders to obey the same: Provided, that those so ordered to active service shall take temporary rank among themselves, and in their grades in the sections to which assigned, according to the dates of orders placing them in active service; and they may be promoted in accordance with such rank to fill vacancies that may occur in the section to which they are assigned: Provided further, that officers of the scientist officers' reserve corps shall not be entitled to retirement or to retired pay, and shall be entitled to pension only for disability incurred in the line of duty and while in active service.

Any officer who, while holding a commission in the

scientist officers' reserve corps, shall be ordered to active service by the Secretary of War, shall, from the time he shall be required by the terms of this order to obey the same, be subject to the laws and regulations for the government of the army of the United States, in so far as they are applicable to officers whose permament retention in the military service is not contemplated.

Section 39 of the above mentioned order has been changed to read as follows:

Instruction of Officers of Scientist Officers' Reserve Corps.—To the extent provided for, from time to time by appropriations for this specified purpose, the Secretary of War is authorized to order reserve officers in the scientist reserve corps to duty in plants, factories or industries, or for theoretical instruction for periods not to exceed 30 days in one calendar year, and while so serving such officers shall receive the pay and allowances of their respective grades in the regular army: Provided, that with the consent of the reserve officers concerned and within the limits of the funds available for the purpose, such periods of duty may be extended for reserve officers, as the Secretary of War may direct: Provided further, that in time of threatened or actual hostilities, after all available officers of any section of the scientist officers' reserve corps shall have been ordered into active service, volunteer officers may be appointed to fill such vacancies as may exist in any plant, factory or industry requiring the services of such officers.

Purification of Tannery Wastes

Experiments on the purification of tannery wastes by precipitation with copperas, primary filtration through cinders and secondary filtration through sand, conducted at Luray, Va., and Cincinnati, Ohio, by the U. S. Public Health Service, gave such good results and were so successful in arousing interest among tanneries that three Virginia tanneries combined to build and operate a working-scale plant at Luray with a daily capacity of 10,000 gal., according to the *Engineering News-Record.* The co-operating tanneries are the Deford Leather Co., Luray; the Leas & McVitty Co., Salem; and Cover & Sons, Elkton.

The original tests, which were made at the first-named plant and at the tannery of Haffner Brothers, Cincinnati, have been described by Harry B. Hommon, sanitary chemist, U. S. Public Health Service, Cincinnati, in a paper printed in the Journal of the American Leather Chemists' Society. They show the following results, starting with composite samples from the various elements of the tannery: Suspended solids, reduced from 1200 p.p.m. in the raw wastes to 450 in the settling-tank effluent, to 160 in the cinder, and to 30 in the sand-filter effluent; organic and free ammonia, 70, 55, 30 and 25 respectively; oxygen consumed (30 min. at 96 deg. C.), 900, 530, 205 and 55. The cinder filters were operated at a rate of 250,000 and the sand filters 300,000 gal. per acre. The cinder filter gave 0.29 p.p.m. of nitrites and 6.0 of nitrates; the sand filter 0.17 and 23.0 respectively.

Mr. Hommon expresses the conclusions drawn from the small-scale experiments and their practical application in the larger or 10,000-gal. unit at Luray, as follows:

1. "A storage tank for spent tan liquor is to be used, also for treatment of this liquor with lime sludge if it is strongly acid. As it is customary to discharge tan liquor intermittently or but once a day, this tank is required to distribute the flow throughout the day. For the 10,000-gal. plant at Luray, duplicate tanks, each 10 x 6 ft. in plan and 3½ ft. deep, with dosing appliances, are provided.

2. "A solution tank for the ferrous sulphate (copperas) solution. These tanks are in duplicate, each 1½ x 2½ ft. in plan and 2 ft. deep, and have the necessary regulating devices.

3. "A settling tank of sufficient capacity to allow a minimum detention period of two hours computed on the displacement basis. The tank for this purpose at Luray is 20 x 8 ft. by 11 ft. deep, and contains baffles and scum board.

4. "Cinder filters having a total depth of 5 ft. of cinders, or 4 ft. exclusive of the underdrains. At Luray this is 42 x 30 ft.

5. "Sand filters. Since as good results were obtained in the tests with a depth of sand of 2 ft. as with 5, the sand filter at Luray is divided into three sections having 2, 3 and 4 ft. of sand laid over underdrains which occupy a maximum of 1 ft., sloping to zero at the sides. Separate outlets are provided for each section for taking samples, and provisions were made to increase the depth of the shallow sections if it becomes necessary. These filters, as well as the cinder filters, will operate at a rate of 200,000 gal. per acre per day.

6. "Sludge beds, with sloping bottoms, containing 1 ft. of cinders overlaid with 4 in. of sand. For a 10,000-gal. unit treating the type of wastes produced at Luray, an area of about 600 sq. ft. is required.

"In the operation of the testing units," states Mr. Hommon, "it was found that better results were obtained by operating the filters at low rates throughout the 24 hours, rather than applying the entire dose for a given rate during the working day. In the permament unit the settling tank is designed to store enough wastes during the day to operate the filters during the 14 hours the tannery is not in operation. During the latter part of the tests, sand filters 2 ft. deep gave as satisfactory results as the deeper filters, but these filters were only 1 ft. in diameter and the results were not directly comparable. It seemed advisable, however, to construct the larger filter in the permament unit of three different depths to definitely decide this point.

"It is recognized that a testing station operated under the constant supervision of a technical man may produce better results than can be obtained from the operation of a large plant under the control of an unskilled operator. It is also appreciated that small units like those operated in the tests may be more readily adjusted to temperature changes and other unfavorable conditions affecting the results. It was to learn how far the results obtained from the operation of the testing units could be duplicated in a large plant that recommendations were made to the tanners interested that they build and operate a large unit.

"The plant now under construction at Luray is to be under the general supervision of the government, but this will extend only to making analyses of samples sent to the government laboratory, and to occasional visits for the purpose of suggesting changes in construction and operation."

The 10,000-gal. plant has been in operation since the latter part of June, 1917. Although without technical supervision it is giving results even more satisfactory than those obtained by the small-scale tests.

The Public Health Service will publish a detailed report in the near future containing complete descriptions of the plants and the results obtained. Progress reports will also be published giving the results from the operation of the permament unit. The general supervision of the work described was conducted by Prof. Earl B. Phelps, Washington, D. C., under the immediate charge at Cincinnati field headquarters of Mr. Hommon.

Government Control of Iron-Ore

The British Minister of Munitions has assumed control of the iron mines of Cumberland and the Furness district of Lancashire. The iron ore of these mines is hematite of the highest quality, occurring as a replacement in limestone, and it was the ore on which Bessemer developed his process. At many of the mines there are surface dumps of low-grade ore that will under present conditions repay concentration.

What the Exhibitors Showed at the Exposition

Descriptions of Exhibits and General Photos of the Exposition

PAUL O. ABBÉ, New York. Five different types of ball and pebble grinding mills. The improved rotary cutter. Combined sifting and mixing machine. In charge of exhibit, Paul O. Abbé. Victor H. Werner, sales engineer. Ralph Garlick, supt.

ABBÉ ENGINEERING CO., New York. Line of Abbé ball and pebble mills, small tube mills, pulverizing machinery, rotary cutter.

H. R. ACKERMAN CO., INC., New York. Samples of aniline and dry colors, acid silk black P. X., acid wool black 4BX.

ACME TANK CO., New York. Wood tanks, Redwood tanks, Redwood pipe. In charge of exhibit, Frank Wenneis.

WM. AINSWORTH & SONS, Denver, Colo. Chemical balances with improved rider carrier and multiple rider attachments. In charge of exhibit, Robt. G. Ainsworth.

ALBERENE STONE CO., New York. Stoneware for laboratory tables, sinks, hoods, etc.

AMERICAN ANILINE PRODUCTS, INC., New York. Samples of dyes and dyed materials.

AMERICAN BITUMASTIC ENAMELS CO., New York. Showed various applications of Hermastic coatings in construction and industrial work, for protection against corrosion and for waterproofing.

AMERICAN BLAUGAS CORPORATION, New York. Compressed gas for laboratory use, lighting, cooking, etc. By-products of gas manufacture. Low explosive range. Mr. Geo. E. Beves in charge.

AMERICAN CERAMIC SOCIETY. Reception booth.

AMERICAN CHEMICAL MFG. CO., INC., Norfolk, Va. Samples of their "Hippo" waterproofing products and acid proofing products.

AMERICAN CHEMICAL SOCIETY. Reception booth.

AMERICAN COAL AND BY-PRODUCTS COKE CO., Chicago, Ill. Diagrams of Roberts flueless coke ovens, and by-products made therefrom.

AMERICAN CYANAMID CO., New York. Evolution of Cyanamid display; 8 large samples, including limestone, burnt lime, coal, coke, carbide, air, crude Cyanamid, Cyanamid. Cyanamid Secondary Products Display—10 samples, including synthetic nitric acid, synthetic urea, aqua ammonia, cyanide, ammonium sulphate, ammonium nitrate, Ammo-Phos, soilime (lime residue), Dicyandiamid; also phosphate rock. Birdseye view of Cyanamid Works at Niagara Falls. List and description of cyanamid products. Four panels: Water Power and Food; A Billion a Year from the Air; To Reduce Fertilizer Costs; Cyanamid Works, Ammo-Phos Works, Phosphate Mines Data. In charge of exhibit, E. J. Pranke, A. E. Bonn, J. P. Hubbell, C. D. Cohen.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Reception booth.

AMERICAN INSTITUTE OF MINING ENGINEERS, New York. Reception booth. Exhibit of minerals.

AMERICAN LA FRANCE FIRE ENGINE CO., New York. Fire extinguishers, gas masks, smoke helmets, and other fire and safety devices, including the Haywood acid hood.

THE AMERICAN METAL CO., New York. Spelter, lead, copper, gold, silver, gallium, platinum, palladium, zinc sulphate, copper sulphate, zinc oxide, zinc dust, salt cake, niter cake, muriatic acid, sulphuric acid, 60°+66° Be. molybdenite concentrates, zinc and lead minerals and ores. In charge of exhibit, H. M. Burkey.

AMERICAN STEEL PACKAGE COMPANY, Defiance, Ohio. "Defiance" steel drums.

AMERICAN SYNTHETIC COLOR CO., Stamford, Conn. Organic chemicals and intermediates. Mr. Hazzard in charge.

AMERICAN TRANSFORMER CO., Newark, N. J. Transformers for electrochemical or electrometallurgical use. High voltage transformers for Cottrell precipitation system.

ANACONDA COPPER MINING COMPANY, Perth Amboy, N. J. Exhibiting products showing various steps in the reduction of copper, starting from the Butte ores, to the commercial refined copper shapes such as ingots, wire bars, slabs, cakes, etc. Also an extensive exhibit of the important byproducts obtained in the electrolytic refining of copper such as copper sulphate, nickel sul-

phate, white arsenic, selenium in all its allotropic modifications, tellurium, silver, gold, platinum, palladium. Also are showing an extensive exhibit of Anaconda Electric electrolytic zinc, and zinc dust and the products of the International Lead Refining Co. Corroding lead, antimonial lead and common lead. In charge of exhibit, S. Skowronski, E. Oksen, R. P. E. Hermsdorf.

H. REEVE ANGEL & CO., INC., New York. Filter paper, "Labruco" rubber tubing, industrial filter papers, fat free strips for milk analysis, Whatman drop reaction papers, extraction thimbles, glass wool. In charge of exhibit, B. S. Proper and G. H. Brother.

ANTI-HYDRO WATERPROOFING CO., Newark, N. J. Demonstration of anti-hydro waterproofing compound, for rendering concrete, etc., waterproof, acid and alkali proof, oilproof and dustless.

APEX CHEMICAL CO., Brooklyn, N. Y. Finishes for wool, cotton and silk. Dressings for leather, discharge agents. Fixing agents for colors, sulphonating oils. Dr. S. M. Herman, Hugo Helburn, Chas. B. Rasenberger, Nelson Craig.

ARKELL SAFETY BAG CO., New York and Chicago. Elastic paper linings for bowls, drums, boxes and bags. E. D. Greene and Pedro J. Morales in charge.

ARMSTRONG CORK & INSULATION CO., Pittsburgh, Pa. Nonpareil insulating brick, Nonpareil corkboard insulation, Nonpareil high pressure covering, Nonpareil cork machinery isolation, Circle A cork brick, Linotile. Herbert Paschke, N. Y. representative, in charge.

ARNOLD, HOFFMAN & CO., New York. Sole agents for the Mathieson Alkali Works, Saltville, Va., and Niagara Falls, N. Y.; Nitrogen Products Co., Saltville, Va. Soda ash, caustic, bicarbonate, bleach, sodium ferrocyanide, sodium cyanide, starch, gums, and various other chemicals. Messrs. Hayes and Hall in charge.

J. T. BAKER CHEMICAL CO., Phillipsburg, N. J. Samples of "Bakers Analyzed" chemical reagents. In charge of exhibit, J. T. Baker.

BALTIMORE, MD., city exhibit, showing the industries of Baltimore, including chemicals, metallurgical industries and allied chemical industries. A model of the city was also on display.

BARBER ASPHALT PAVING CO., Philadelphia, Pa. They showed various chemical and industrial products into which Trinidad and Bermudez Natural Lake Asphalts and Gilsonite enter as a base material. They are featuring with a microscopic exhibit the collodial matter occurring in Trinidad asphalt, also a method for lining acid tanks with an asphalt mastic material. They are also showing their very complete line of roofings, shingles, paints, sealing compounds, marine enamels, etc. During the week a moving picture exhibit was given showing in detail the history of Trinidad Lake Asphalt and products produced therefrom. In charge of exhibit, H. C. Hottel, H. M. Menner, E. J. Carlin, Theo. Thomas. A. S. Lewis, J. S. Miller, Jr.

BARRETT COMPANY, New York. A complete display of the products of coal distillation.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y. Metallurgical microscope, metallographic equipment, photomicrographic apparatus.

THE BAYONNE CASTINGS CO., Bayonne, N. J. Monel metal castings and rods and nickel castings. Had the largest nickel casting made in U. S. A., on exhibition at their booth No. 293. In charge of exhibit, H. F. Chase, sales manager, J. L. Fitzheury and F. N. Longyear

BEACH-RUSS CO., New York. Vacuum pumps, automatic oiling systems.

BECKLEY PERFORATING CO., Garwood, N. J. Miniature drying oven, high pressure ammonia tank, centrifugal tank, special tanks of all kinds. Perforated metals, brass, copper, steel, lead, aluminium, monel metal for sizing and straining purposes. Storage tanks of all sizes. Electrically welded steel any shape desired. In charge of exhibit. Allen L. Price. Theodore P. Carlson.

BETHLEHEM FOUNDRY & MACHINE CO., New York. Chemical apparatus of tantiron. acid eggs, caustic pots, nitrators, autoclaves, comparative test showing corrosive action of a 2 to 15-lb. solution of nitric acid on tantiron and cast iron, with resistance of the former.

P. BLAKISTON'S SON & CO., Philadelphia, Pa. Scientific books.

VICTOR G. BLOEDE CO., Baltimore Finishing Co., Viscamite Co., Baltimore, Md. Gums, dextrines, dyes, chemicals and colors. Exclusive contract with Government for gum on postage stamps. Dyers and finishers of cotton fabrics. Specializing in khaki, clothing, wigans starch finishes and general finishes for cotton clothing cloth. Viscamite, patented vegetable glue to replace animal glue. In charge of exhibit, V. Bloede, E. L. Greensfelder, L. B. Kilmer.

BOOTH FELT CO., INC., Brooklyn and Chicago. Samples of mechanical felt goods and felt specialties of all kinds. Mr. Booth and Mr. Gaizer in charge.

BOYER OIL CO., New York. Vegetable seed and nut oils.

THE BRASSARD CHEMICAL CO., New York. The main feature of The Brassard Company Incorporated's attractive exhibit this year was a map of the Atlantic Ocean showing the United States and the Western European countries connected by steamship lanes to various ports, illustrating the export connections of the company. They have specialized in the exportation of drugs, industrial chemicals, paint makers', varnish makers' and leather manufacturers' supplies. Another interesting exhibit is that of "British-made" Sulphur dyes (Hydrosulphon colors), manufactured by F. à Brassard & Crawford of Wakefield, England, one of the products particularly commented on being Hydrosulphon Indigo, with which a very fine indigo shade is obtained. Mr. W. A. à Brassard, president of the company, and Mr. Henry C. Elfast, were in attendance at the booth.

BRISTOL COMPANY, Bristol, Conn. Line of Bristol temperature indicators and controllers. Manufacturers recording instruments.

BROWN INSTRUMENT CO., Philadelphia, Pa. Demonstration of Brown pyrometers, Brown recorder for determining critical points of steel, Brown 8-record recording pyrometer and remote signaling pyrometer.

BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y. The principal feature of this exhibit was a large vacuum drum drier for acids, chemicals, paints, glues, milk, food products and extracts. The main casing of this apparatus cast in one piece weighing 50,000 lb. When completely assembled the machine weighs 100.000 lb. The inner drying drum is 5 ft. diameter and 12 ft. long. A smaller size of this apparatus was in operation. Other exhibits comprised a Buflokast nitrator, fusion kettle, autoclave and apparatus used in producing heavy chemicals, acid, alkalis, explosives, intermediate products for dyes, etc. A piece of special interest was a new vacuum crystallizer for evaporating and crystallizing various materials. There was also a Buflokast denitrator for recovery of waste acids, capable of recovering nitric acid from waste containing as low as 2 per cent nitric acid and up to 30 per cent water, particularly from waste acids obtained in making gun cotton, TNT, dinitrobenzol, etc. The balance of the exhibit comprised Buflovak vacuum shelf driers and the new rapid circulation type evaporator. In charge of exhibit, E. G. Ripple, sales manager; H. D. Miles, president; O. S. Sleeper, P. J. Krentz, D. J. Van Marle, Otto Mantius, J. E. Doughton, Chas. Lavett, E. G. Sleeper, Homer Case, Geo. Pezold, H. Underwood, D. Bell, W. Dougan, Albert Feltz.

BUTTERWORTH-JUDSON CORPORATION, New York. Acids, chemicals, intermediates, dyestuffs. In charge of exhibit, E. E. Dougherty, G. T. Quinn. Dr. G. Drobegg, Dr. M. L. Hamlin, W. A. Lucas, W. H. Clark.

CALCO CHEMICAL CO., Bound Brook, N. J. Samples of the various dyestuff intermediates and finished dyes made by this company.

JOHN CAMPBELL & CO., New York. Aniline colors. In charge of exhibit, E. O. Attwater.

CANADIAN CHEMICAL JOURNAL, Toronto. Reception booth.

CANADIAN COLOR & OIL DAILY. Reception booth.

CARBORUNDUM COMPANY, Niagara Falls, N. Y. Carborundum products, pyrometer protection tubes, refractories, furnace linings, firebrick, firesand.

CAROLINA, CLINCHFIELD & OHIO R. R., Johnson City, Tennessee. Pottery products, wood products, nonmetallic minerals, metallic minerals. building materials. In charge of exhibit, V. V. Kelsey, Stuart Johnson, J. A. Bates.

CARRIER ENGINEERING CORPORATION, New York. Apparatus for conditioning and drying air. Automatic humidity regulation.

CELITE PRODUCTS CO., New York. Exhibit of sil-o-cel products for high insulating purposes. Brick, powder and various other products. P. A. Boeck, in charge.

CELLULOID-ZAPON CO., New York. Lacquers and leather cloth.

CENTRAL DYESTUFF & CHEMICAL CO., Newark, N. J. Dyestuffs and intermediates.

CENTRAL SCIENTIFIC CO., Chicago, Ill. Exhibit of De Khotinsky, constant temperature drying ovens, water baths, incubators, etc., laboratory rheostats, analytical balances, Pyrex glassware, organic and industrial chemicals, etc.

EXHIBITS
ON THIRD FLOOR
NEWPORT CHEMICAL WORKS
TAKE ELEVATOR
FOR EXHIBITS
ON THIS FLOOR
TOLHUR

CHEMICAL CATALOG CO., New York. Reception booth.
CHEMICAL COMPANY OF AMERICA, INC., New York. Samples of dyestuff intermediates and finished dyes.
CHEMICAL CONSTRUCTION CO., Charlotte, N. C. Reception booth.
CHEMICAL ENGINEER, New York. Reception booth.
CHEMICAL PUMP AND VALVE CO., Perth Amboy, N. J. Valves, check valves, packingless centrifugal pumps, etc. Mr. Antisell in charge.
CHEMISTS' CLUB, New York. Reception booth, photos of famous chemists.
CHILE EXPLORATION CO., Chile Copper Co., Chuquicamata, Chile. Copper ingots, the ore used, samples of electrolytic solutions, acid proof mastic tank linings and acid proof pipe.
CHROMOS CHEMICAL CO., INC., New York City. Benzoic acid, benzoate of soda, tannigen, ferro benzoate.
CLARK'S IRON FOUNDRY, Philadelphia, Pa. Clarkiron chemical castings. Large size acid blow case and sulphuric acid concentrating pan and cover.
CLENZALL MACHINES CO. OF AMERICA, St. Louis, Mo. Working model of Clenzall filter cloth washing machine. Mr. F. H. Ehnts in charge.
CLINCHFIELD PRODUCTS CO., New York. Barium products, sodium sulphide, feldspar.
CONDENSITE CO. OF AMERICA, Bloomfield, N. J. Phenolic condensation products, chlorinated naphthaline products, condensite and halowax. Molded electrical insulation as applied to automobile starting, lighting and ignition apparatus, molded commutators, high tension insulators, U. S. Navy wireless insulators and lamp sockets, electrical condensers and miscellaneous insulation, condensite molding preparations, impregnating enamels and cements. Halowax oils and synthetic waxes. Molded condensite as used in Edison disc phonographic records, moving picture machines, vending machines, fire extinguishers, welding goggles, surgical, dental and chemical apparatus, etc. In charge of exhibit, Sandford Brown, chief engineer.
CONSOLIDATED COLOR & CHEMICAL CO., New York. Colors, sizing and finishing materials, soluble oils.
CONTACT PROCESS CO., Buffalo, N. Y. Samples of sulphuric, nitric and hydrochloric acids, sulphide of soda, mixed acid, oleum, salt cake, nitre cake.
CORN PRODUCTS REFINING CO., New York. Corn products for technical purposes. Dextrines, starches, gums, oils, cellulose.
CORNING GLASS WORKS, Corning, N. Y. Chemical glassware, beaker's flasks, etc., made of Pyrex glass. Bakingware, Pyrex; railroad glassware, colored glass, instrument tubings, bulbs. Also showing Macbeth color Indication Unit, which is equipped with Corning glass. In charge of exhibit, J. F. Shaw, advertising manager.
THE CRANDALL PETTEE CO., New York. Revolving gas oven for all kinds of baking and drying purposes. This appliance is equipped with a heat regulator by which any desired degree of heat can be obtained and maintained constantly for any length of time without the attention of an attendant. Oven weighs two and a half tons and is suitable for all kinds of manufacturing purposes. In charge of exhibit, Paul Delaney.
CRANE CO., Chicago. Show a large line of valves and fittings for steam water, air, etc., in cast and malleable iron, ferro steel and cast steel. Among the specialties are an automatic stop check valve for boilers, a blow-off valve and the "Cranelap" Pipe Joint. Of particular interest is a complete 5-horse power industrial steam plant in actual operation. This miniature plant embodies the "Crane-auto" boiler-feeding system; the Crane Pressure Regulator and Temperature Regulator and the Cranetilt Lifting and Non-return Steam Traps. A coil kettle is heated to a definite temperature by the boiler, and the condensation is returned to the boiler —100 per cent efficiency is claimed. In charge of exhibit, W. L. Oswald. William Sink.
CRESCENT COLOR & CHEMICAL WORKS, New York. Colors and lakes.
THE J. H. DAY CO., Cincinnati, O. Demonstrating all kinds of mixing machinery. For heavy and light pastes, liquids and dry materials. R. W. Wallace, New York manager, in charge.
DE LAVAL SEPARATOR CO., New York. Centrifugal separators.
DENVER FIRE CLAY CO., Denver, Col. Metallurgical clay goods, crucibles, scorifiers, muffles. Clay tile, etc. Melting, assaying and enameling furnaces. Crushing and grinding machinery. In charge of exhibit, Messrs. Case and King.
DETROIT CHEMICAL WORKS, Detroit, Mich. Manufacturers of sulphuric acid, nitric acid, sulphate alumina. (Display samples lost en route.) In charge of exhibit, Edward S. Davis, secretary; Emerson Davis, treasurer.
DETROIT RANGE BOILER CO., Detroit, Mich. Exhibit a line of Perfect Metal Bilge-Barrels and Shop Barrels. Of peculiar interest is their Full Removable Head Barrel. In charge of exhibit, W. B. Goddard.
J. P. DEVINE CO., Buffalo, N. Y. A large Vacuum Drying Chamber that is a unit adapted to the handling of all materials that can be handled on trays or pans. There was installed in the J. P. Devine Co.'s booth a laboratory Vacuum Chamber Dryer Outfit complete with its condenser and dry vacuum pump. Also installed a Devine High Efficiency Vacuum Rotary Dryer that is a unit adapted to drying all materials that can be mixed or tossed in the drying. A 100 Gallon High Pressure Cast Steel Autoclave also on exhibition. Mr. Nathan Owitz, sales manager of the company, was in charge of the exhibit, and was assisted by Mr. L. W. Treichler, manager of the New York office, and Mr. A. D. Renner. Mr. F. F. Frantz, from the Buffalo office, is in charge of the moving apparatus.
DIAMOND STATE FIBRE CO., Bridgeport, Pa. Various samples of vulcanized fibre waterproof insulators. In charge of exhibit, R. F. Hunt, C. M. Bogert and Jas. McIntosh.
DOMINION OF CANADA, Department of Mines. Reception booth and maps showing mineral resources and water powers of Canada. J. T. Johnston, chief hydraulic engineer of the Government, in charge.
DORR COMPANY, New York. Operation of Dorr tray thickener and Dorrco diaphragm pump. Dorr agitator and classifier. In charge of exhibit, Messrs. J. V. N. Dorr, Fox, Spicer and Schaefor.
DOW CHEMICAL CO., Midland, Mich. Indigo, dyestuff intermediates and other chemicals.
THE DRAEGER OXYGEN APPARATUS CO., Pittsburgh, Pa. The Pulmotor, a mechanical resuscitation device for use in resuscitating the apparently drowned or asphyxiated from any cause. The Draeger Breathing Apparatus for breathing in any noxious fumes or smoke. In charge of exhibit, S. N. Fowler, O. L. Goudey, C. C. McDaniel.
DRAPER MFG. CO., Cleveland, Ohio. Drums for all purposes.
DURIRON CASTINGS COMPANY, New York. Duriron Acid Alkali Rust Proof Apparatus, including 2 x 1½ in. centrifugal pumps, 4 x 8 in. gear pump and reciprocating pump, newly designed triplex pump, capable of pumping against 300 lbs. pressure. Hough nitric acid condenser, plug cocks and valves, pipe and fittings, mixing kettle in operation, spray nozzles, laboratory apparatus, sulphuric acid cascade basins, absorption tower and plate-pipe showing special threaded connection to eliminate bolts for joints under surface of corrosive liquids, acid carboy lift, sundry special castings. In charge of exhibit, J. R. Pitman, Peirce D. Schenck, J. S. Miller, Jr., Fred W. Kolb, P. C. Schatzabel.
DYE PRODUCTS & CHEMICAL CO., INC., New York. Samples of aniline dyes for wool, silk, leather, paper and furs. Dyestuff intermediates.
EIMER & AMEND, New York City. Laboratory apparatus of all kinds, multiple replaceable unit, electric furnaces, Barnstead automatic water still, Erichsen metal sheet tester, Brinell hardness tester, etc.
ELECTRO BLEACHING GAS CO., New York. Liquid chlorine and products bleached with it.
ELECTROLYTIC ENGINEERING CORPORATION, New York. Photos showing actual installations of the Wheeler cell for making chlorine and caustic soda. Mr. Wheeler in charge.
ELECTROLYTIC ZINC CO., New York. Slab zinc 99.92 per cent pure, zinc wire, 99.92 per cent zinc shot, granulated zinc, zinc carbonate sulphate, oxide and chloride. W. H. Nagle in charge.
ELECTRON CHEMICAL CO., Portland, Maine. Photos of installations of the Allen-Moore chlorine and caustic soda, cell.
G. H. ELMORE, BLAIR, CAMPBELL & McLEAN, LTD., Scotland and New York. Designing and construction of chemical plants.
THE ELYRIA ENAMELED PRODUCTS CO., Elyria, Ohio. One seamless one-piece closed jacketed tank, 300 gallons capacity, with agitator. This has patented stuffing box jacket which allows quick renewal of inside tank and replacement by a new piece if severe chemical action causes wear. Also a cast iron jacketed still with

EXHIBITS

agitator. Every part quickly interchangeable, all made to gage. Also small and large steam jacketed evaporating kettles or dishes. Also steam jacketed kettle, 25-gallon capacity. All are arranged so that any part is easily replaceable. The cast iron enamel is very highly acid resistant and can be used with mineral acids of all kinds. Other small dishes, etc., are also shown. In charge of exhibit, Wm. E. Gray, John O'K. White, E. P. Poste, R. F. Goecke, Wm. E. Gray, Jr.

EMPIRE CHEMICAL CO., New Brunswick, N. J. Para toluidine, Ortho toluidine, W. S. nigrosene, jet, W. S. nigrosene, blue, S. S. nigrosene, blue, Para nitro aniline, mixed toluidine, Para nitro Ortho toluidine, Meta nitro Para toluidine, Para Amido phenol, Para nitro chor benzol. H. R. Cook in charge.

EQUITHERM CONTROL CORPORATION, New York. Industrial temperature control and electrical appliances electrically operated thermostats for all purposes to 1650 deg. F. Valves for low pressure steam, 2 in. to 14 in. High pressure steam, ½ in. to 6 in. Oil and air, brine, gas, oil and steam, gas and air, water, electric heat, oil, ammonia control. In charge of exhibit, E. B. Lane, H. W. F. Threse.

W. & L. FLEISHER & CO., INC., New York. Drying and air conditioning laboratory, in which any condition of temperature and humidity desired can be obtained. Working model under automatic control. In charge of exhibit, Messrs. Lissauer, Peabody, Fleisher.

FOOTE MINERAL COMPANY, INC., Philadelphia. As specialists in rare and semi-rare ores and mineral products the Foote Mineral Company of Philadelphia featured many materials of growing commercial interest, notably the following: "Cooperite," a patented alloy of nickel and zirconium, intended mainly for use in cutting tools for lathes, planers, boring mills, etc., was shown in mill bars and finished tools. Possessing a melting point of only about 1150 deg. C, this alloy can readily be cast, requiring no heat treatment, and only a minor grinding operation to finish. In a recent series of comparative te :ts at one of the large Eastern steel companies in cutting steels of varying degrees of hardness, "Cooperite" tools averaged several times longer before regrinding than the best grades of high speed steels. Among the ferro-alloys of tungsten, vanadium, uranium and tantalum, ferro-molybdenum finds its most important application in high grade steels, being used for rifle linings, armor plate, armor piercing shells, permament magnets, bank vaults, self-hardening and high speed machine tools. Molybdenum steel compares very favorably with tungsten steel and does not require as high a temperature for hardening. Several grades of Crimson and Golden Antimony were shown, especially adapted for use in the rubber industry; also thorium ore (monazite sand), from which the nitrate is obtained for use in the gas mantle industry; crude strontium sulfate, first imported by this company for the manufacture of the nitrate; cerium mixed metal, intended especially for the manufacture of pyrophoric alloys; "Zirkite" (natural zirconium oxide), which is being more and more recognized as a high grade refractory; manganese ore suitable for use in the dry battery and chemical trades; and an unusual collection of "Thulia" brands of the rare elements. In charge of the exhibit, Warren M. Foote, H. Conrad Meyer and Charles F. Walton.

FOXBORO CO., Foxboro, Mass.—Pressure and temperature recording and indicating apparatus. High resisting pyrometers, temperature controllers, differential recording gage. In charge of exhibit, Willis C. Brown, M. B. Hall, D. Bogan, L. H. Du Paul, J. E. Esherick.

FOUNDATION COMPANY, New York. Engineers and contractors for chemical plants and factories.

FREEPORT SULPHUR CO., Parsons & Pettit, New York City, Selling Agents. Photos showing extraction of sulphur.

CHAS. F. GARRIGUES CO., New York, agents for Virginia Smelting Co., producers of liquid sulphur dioxide. Samples of various chemicals.

GEISENHEIMER & CO., Agents for Ault & Wiborg Co., Cincinnati, Ohio. Dyestuff intermediates, chemicals, aniline oil and salt. Finished dyes, American and Swiss. Alfred F. Lichtenstein.

GENERAL BAKELITE CO., New York. Bakelite products, molding mixtures, varnishes, lacquers, enamels, cement, transparent and colored in sheet, rod, tube and special forms.

GENERAL CERAMICS CO., INC., New York. Western Sales Office, 112 West Adams St., Chicago, Ill. High grade, acid proof chemical stoneware apparatus and machinery. Those in charge, Percy C. Kingsbury, Evan S. Cameron.

GENERAL CHEMICAL CO., New York. Heavy chemicals. In charge of exhibit, J. E. Wilson, Jas. A. Branegan, J. R. de la Torre Bueno, N. L. Blay.

GENERAL ELECTRIC CO., Schenectady, N. Y. Indicating, recording, integrating steam or water flow meter. Tungsten metal and products. Coolidge X-ray tube.

GENERAL FILTRATION CO., Rochester, N. Y. Filtros plates, shapes, filters, etc.

GLENS FALLS MACHINE WORKS, Glens Falls, N. Y. Rotary sulphur burner.

GORDON ENGINEERING CORPORATION, New York. Standard size, two-section, Gordon dryer. In charge of exhibit, D. S. Baker, L. B. Darling, Mr. Murray.

GOULDS MANUFACTURING COMPANY, Seneca Falls, N. Y. Single-stage and two-stage centrifugal pumps, also rotary and plunger pumps, general water supply and special service pumps. In charge of exhibit, Harry R. Gumbert, W. H. Hopper, Harry Angel.

EMIL GREINER & CO., New York. Laboratory glassware specialties, centrifuges, electrically heated ovens.

GROCH CENTRIFUGAL FLOTATION, LTD., Cobalt, Ont. Working model of a complete oil flotation plant including tube-mill for ore crushing and agitator for the recovery of valuable minerals by the oil process. The distinctive feature of the Groch system is that agitation of the crushed ore with the oil and air is affected centrifugally in the interior of specially designed impellors and that by using suitable oil mixtures in series, various minerals in a complete ore can be recovered individually in one continuous operation.

THE GUERNSEY EARTHENWARE CO., Cambridge Ohio. Line of chemical laboratory porcelain, such as evaporating dishes, crucibles, retorts, funnels, porous cells, desicator plates, casseroles, combustion boats, mortars and pestles, pyrometer tubes, melting cups, porcelain spoons and spatulas, dye pots, etc., etc. In charge of exhibit, Allan L. Goulding, Prof. Paul E. Teetor.

HANOVIA CHEMICAL & MANUFACTURING CO., Newark, N. J. Samples of quartz glass, Heraeus laboratory apparatus, pyrometers, etc.

HARDINGE CONICAL MILL CO., New York. Small size, working model, Hardinge conical mill. Photos of many installations.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Working model of "Cochrane" V-notch meter in actual operation. Demonstration of hot process water softening. Cochrane separators and multiport valves, also a Creasy ice breaker. J. D. Yoder and W. W. Montalvo in charge.

HELLENIC CHEMICAL & COLOR CO. Samples of lakes and dry colors, anilines, intermediates and other chemicals. L. O. Seawood in charge.

HOSKINS MFG. CO., Detroit. Electric laboratory furnaces, pyrometers, indicating and recording; chromel thermocouples, resistor wire. In charge, F. L. Zimmerman, New York representative; C. S. Kinneson, advertising manager.

IMPERIAL COLOR WORKS, INC., IMPERIAL DYEWOOD CO., INC., JOHN H. HEALD & CO., INC., New York. Arthur Linz, New York sales manager; Wm. E. Burdett, secretary; K. R. McBride, in charge.

INDEPENDENT CHEMICAL CO., Sterling Color Co. (branch). Heavy acids. O. Crispens in charge. Prinuline S. F., direct fast yellows, reds, pinks, violet shades, all of which are fast to acid. R. H. Ringen in charge.

FRANK HEMINGWAY, INC., New York. Agents for Butterworth-Judson Corp. Samples of intermediates, dyestuffs, pharmaceuticals, special oils and greases, lake colors.

S. S. HEPWORTH CO., New York. Small standard size Mackintosh ball bearing centrifugals. D. M. Gardner in charge.

B. MIFFLIN HOOD BRICK CO., Atlanta, Ga. Acid proof brick, various shapes, spiral rings, radial towers and packing for Gay-Lussac and Glover towers. The spiral rings were of special interest in view of the difficulty of obtaining a correct spiral in a clay product.

HERCULES ENGINEERING CORP., New York. New Reed bowl, three-speed mixer. Mr. F. Mason.

HEROLD CHINA & POTTERY CO., Golden, Col. Exhibit of Coors porcelain ware for laboratory and industrial use. Evaporating dishes, casseroles, crucibles, boats, etc. Chas. F. Quaintance in charge.

HOOKER ELECTROCHEMICAL CO., Niagara Falls, N. Y. Chlorine, caustic soda and chlorbenzol products.

HOUSTON (Texas) REAL ESTATE & LOAN CO. Samples of Texas raw materials and products.

HUFF ELECTROSTATIC SEPARATOR CO., Boston, Mass. Demonstration of concentrations and separations produced by static electricity. Demonstration of the Plumb Pneumatic Jig for dry concentration of ores, wide range of results on samples of concentrations and separation of ores, on display. In charge of exhibit, A. L. Sweetser, member A. I. M. E.

HUNTER DRY KILN CO., Indianapolis, Ind. Processing and drying of rubber and compounds, using moist-air kilns, drying "from the inside out." In charge of exhibit, Harry Hunter, O. M. Ragsdale.

F. C. HUYCK & SONS, Albany, N. Y. Photos of the manufacture of "Kenwood" woolen filter cloths for chemical and industrial filtering purposes. Messrs. Wallace and McGovern in charge.

INDUSTRIAL FILTRATION CORP., New York. All metal rotary filter, type B-1. All metal rotary hopper dewaterer, type C-1. Open tank filter, type D-1. All models of the above types exhibited are exact miniatures of the standard machines. In charge of exhibit, Wm. H. Harding, Jr.; Henry B. Faber, George D. Dickey, Wm. H. Laughery, J. Rayden Hess.

INTERNATIONAL EQUIPMENT CO., Boston, Mass. Showed commercial and laboratory centrifugals.

INTERNATIONAL GLASS CO., Millville, N. J. Chemical glassware and apparatus for laboratory use.

JACQUES WOLF & CO., Passaic, N. J. Monopole oil (U. S. patentees), sulphonated castor oils, sizing and finishing products of cotton, wool and silk, mordants, gums, chrome colors for fabric printing.

JANNEY STEINMETZ & CO., Philadelphia, Pa. Pots and pans, special shapes high pressure cylinders. E. K. Mason, N. W. Slater, Manager N. Y. office, in charge.

JEWELL-POLAR CO., Chicago, Ill. Various types of Jewell-Polar stills.

JOURNAL OF COMMERCE, New York. Reception booth.

JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY, New York. Reception booth.

KALBFLEISCH CORPORATION, KALBPERRY CORPORATION, New York City. Kalbfleisch Corporation showed samples of acids and chemicals made by the company. Kalbperry Corporation, industrial engineers.

KEYSTONE FIBRE PRODUCTS, INC., New York. Solether Gasket-Sheeting, a fibrous product for use in chemical plants, factories, mills, power houses., etc. Exhibit showing variety of unusual chemical tests and comparisons with other high class gaskets or packings. Also showing rolls of material of different thicknesses and widths as offered to the trade. In charge of exhibit, General Manager George H. Bruce, N. L. Morton, Engineer, and A. J. Schweiger, assistant.

KEYSTONE MINERALS CO., New York. Samples of Rottenstone, velvet filler, Keystone filler, mineral black. In charge of exhibit, Daniel Wonders and F. J. O'Brien.

KLEET MFG. CO., INC., New York. "Percollodion" membranes for rapid evaporation and crystallizing in laboratory work. Kober colorimeter nephelometer for measuring color and turbidity. In charge of exhibit, Messrs. R. E. Kleet, F. A. Boersch and C. W. Eberlein.

A. KLIPSTEIN & CO., New York. Dyestuffs, chemicals and tanning materials.

KNOXVILLE BOARD OF COMMERCE, Knoxville, Tenn. The Knoxville exhibit at the Chemical Exposition is designed to show, in physical displays and by maps and charts, the various varieties of minerals in the territory of which it is the geographical center, and, by virtue of its unique central location, emphasize its importance as a manufacturing center for plants utilizing the mineral resources surrounding the city on every side, as well as for plants that use the finished products of plants already in operation in that section. Among the metallic minerals shown in the Knoxville exhibit are to be found copper ore, iron ore, zinc ore, lead ore, bauxite, manganese. The non-metallic minerals include clays, shales, mica, phosphate, limestone, pigments. Petroleum is also an important resource exhibited, as is coal. Knoxville is within thirty miles of the nearest coal field in the Tennessee-Kentucky district and six miles of the farthest. Knoxville marble is also featured and is being advocated as a substitute for any material used for its lime content, the Knoxville stone analyzing 98 per cent calcium carbonate. It is also urged as an element in the manufacture of Portland cement. Forestry products are also interestingly exhibited. In charge of exhibit, Hugh M. Tate, Dr. C. H. Gordon, Prof. J. A. Switzer, A. M. Blow, C. A. Benscoter and J. L. Bowles.

H. KOPPERS CO., Pittsburgh, Pa. Map showing coke and benzol products in United States. Samples of coke and by-products made by the Seaboard By-Product Coke Co., Jersey City, N. J., in Koppers coke ovens.

THE LABORATORY SUPPLY CO., Columbus, O. Show a complete line of the well known quality of "Ohio" tested porcelain and guaranteed glassware. In charge of exhibit, R. C. Schroth, Jr., C. D. Fraunfelter.

LEAD LINED IRON PIPE CO., Wakefield, Mass. Forms of lead-lined pipe, valves and stop-cocks.

LEEDS & NORTHRUP CO., Philadelphia, Pa. A complete line of pyrometers, including both recording and optical pyrometers. The optical pyrometer is of especial interest, possessing both accuracy and simplicity. In connection with the recording instruments a red, white and blue light system of indicating variation, high or low, of the furnace temperatures from a fixed valve was shown. Apparatus for determining the conductivity of electrolytes was shown including the Vreeland oscillator for delivering a high frequency E.M.F. of pure sine wave. The new design of the Burrows Permeameter for magnetic measurements. Electrometric titration apparatus for determining chromium and vanadium. A useful type of hydrogen electrode was also shown. In charge of exhibit, E. A. Keeler, E. B. Estabrook.

LEHIGH CAR WHEEL & AXLE WORKS, LEHIGH FOUNDRY CO., LEHIGH STOKER CO., Fullerton, Pa.; FULLER ENGINEERING CO., Allentown, Pa. Small model of Fuller-Lehigh pulverizer mill. Special chilled castings. Photos of large chemical castings, pulverized coal installations and stokers. In charge of exhibit, Messrs. Stauffer, Mease and Stubblebine.

ARTHUR D. LITTLE, INC., Boston, Mass. Industrial research and scientific control. View of Cambridge, Mass., along Charles River, showing buildings of Massachusetts Institute of Technology, new building of Arthur D. Little, Inc.

STATE OF LOUISIANA. Timber, salt, sulphur, farm products.

WALTER E. LUMMUS CO., INC., Boston, Mass. Continuous concentrating and rectifying still, Lummus metrolift for liquids.

EMIL E. LUNGWITZ, New York. One type 450 power operated Kelly Filter Press, one type 30 Kelly Filter Press, one type 3 Kelly Filter Press. The 450 type on exhibit is of the latest and most improved style of Kelly Filter Press. Automatic locking device, power-driven and operating by compressed air. In charge of exhibit, Emil E. Lungwitz, C. L. Bryden, H. L. Dick, Carl Teichman and Herbert E. Soarez.

LUZERNE RUBBER CO., Trenton, N. J. Hard rubber products for chemical and industrial use and general rubber goods.

LUNKENHEIMER CO., Cincinnati, Ohio. A complete line of stop valves, bronze, iron body bronze mounted, all iron, semi-steel, and cast steel; lubricating specialties, boiler mountings, etc. In charge of exhibit, Phil. Smith.

MACHINERY UTILITIES CO., New York. Idle and used apparatus for the chemical industries.

MADERO BROS., INC., New York. Large line of drugs and chemicals.

MANUFACTURERS' RECORD, Baltimore, Md. Reception booth.

MARDEN ORTH & HASTINGS CORP., New York. Dyes, chemicals and textile oils. Display of dyed skeins of cotton, wool worsted and silk. In charge of exhibit, H. Gardner McKerrow, manager; S. M. Crain, Jr., assistant manager.

MERCK & CO., New York. Blue label chemical reagents.

METALS DISINTEGRATING CO., New York. Metallic zinc, tin, lead, aluminium, copper and magnesium powders and zinc, tin, aluminium and copper flakes. In charge of exhibit, S. G. Schatzberg.

THE METH-O-LENE CO., INC. American-made dyes and colors. Exhibits of silks, cottons, straws, papers and crayons. In charge of exhibit, Harry F. Heckendorn.

H. A. METZ LABORATORIES, INC., New York. American-made synthetic local anaesthetics.

MINE & SMELTER SUPPLY CO., Denver, Col. Wilfley table, Marcy mill, Heusser balance with multiple weight attachment and mechanical pan extractor; Samson laboratory construction, McCord pulverizer, McCann sampler, Jones sampler, Mossco crucibles, scarifiers, mufflers, metallurgical clay tile, Lindsay oil furnace, laboratory gas furnace, Coors porcelain ware. In charge of exhibit, J. C. Evans, E. S. Tompkins, J. S. Shedden.

MOGUL CO., New York. Photos of various kinds of acid, alkali and waterproof insulation in actual use.

MONARCH MANUFACTURING WORKS, Philadelphia,

Pa. Chemical atomizing spray in actual demonstration.

MONSANTO CHEMICAL CO., St. Louis, Mo. Samples of acetanilid, aspirin and many other similar products.

MOORE & SIMONSON, New York. Lead burning. In charge of exhibit, W. H. Simonson.

J. L. MOTT IRON WORKS, New York. Enamelled iron kettles, evaporators, etc.

MOULTON ENGINEERING CORPORATION, New York. Photos of chemical and industrial plants, constructed or designed by the company.

MULTI METAL SEPARATING SCREEN CO., New York. Wire cloth, metallic filter cloth, testing sieves, Pulmosan face masks, chlorine helmets, etc.

NASH ENGINEERING CO., Norwalk, Conn. Nash hydroturbing air compressor and vacuum pumps, Jennings return line vacuum heating pumps and dryer exhaust units.

NASHVILLE, CHATTANOOGA & ST. LOUIS RY. A comprehensive exhibit showing not only the wide variety of raw materials available in the South, but the manufactured products made from these raw materials. Very large descriptive map showing the location of the various raw materials.

NATIONAL ANILINE & CHEMICAL CO., New York. Exhibit of the varied line of dyestuffs made by the company and a large number of different kinds of materials dyed with the company's dyes.

NATIONAL GUM & MICA CO., New York. Glues, gelatines and adhesives.

NEW JERSEY PRODUCTS, INC., New York. Coal products, organic chemicals, Edison Portland cement, Edison alkaline storage battery.

NEWPORT CHEMICAL WORKS, INC., New York. Products of coal tar distillation, also turpentine and pine oil from Northern woods.

NEW PROCESS CHEMICAL CO., New York. "Nupro" waterproof and acid-proof cements and paints for chemical and metallurgical purposes. In charge of exhibit, George T. Simonson, August Schlueter.

NEW YORK CITY HEALTH DEPARTMENT. Products of food dehydration.

NEW YORK COMMERCIAL. Reception booth.

NEW YORK REVOLVING PORTABLE ELEVATOR CO.,

Jersey City, N. J., Non-revolving and revolving base portable elevators for heavy lifting such as in piping barrels, cases, bales, rolls, etc., or in lifting heavy drums of chemicals to the height at which they may be either siphoned or the contents poured into a tank or other container. In charge of exhibit, F. J. McMahon and John Kurtz.

NIAGARA ALKALI CO., New York. Caustic soda, caustic potash, chlorine by-products.

NORFOLK & WESTERN RY. CO. Raw materials. Photos of some of the large industrial plants. Possibility for future development. Pyrrhotite (largest deposit in United States). In charge of exhibit, E. A. Schubert.

NORTON CO., Worcester, Mass., and 151 Chambers Street, New York. A practical working exhibit showing the application of alundum and crystolon in the manufacture of refractories and laboratory ware, such as alundum cores, muffles and tubes for small electric-furnace construction; extraction thimbles, filtering crucibles; ignition crucibles, pyrometer tubes, etc. The use of these two materials, alundum and crystolon, as abrasives for nearly all classes of work, from grinding of manganese steel to polishing microscopic specimens of all materials, was also shown. In charge of exhibit, M. A. Williamson, 151 Chambers Street, New York.

OBEX COMPANY, New York. Dye woods and dyestuffs, Logwood, Osage orange, Brazil wood, fustic. Dye extracts and dyed products.

OHIO POTTERY CO., Zanesville, Ohio. American-made chemical porcelain for laboratory use.

OLIVER CONTINUOUS FILTER CO., San Francisco. Two Oliver continuous filters shown in actual operation. R. G. Walker and L. D. Drake in charge.

PALO COMPANY, New York. Hess-Ives Tintphotometer, Dr. Waldo's Hardness Tester, Rhotanium, a substitute for platinum, Palo electric heaters, Palo analytical balances, Link's automatic waterstills, Palo chlorinator, Despatch electric ovens, C. L. & E. electric ovens, multiple unit furnace. In charge of exhibit, F. Rohde, C. E. Thies and M. J. Leavy.

PAPER, INC., New York. Reception booth.

PAPER MILL AND WOOD PULP NEWS, New York. Reception booth.

PENNSYLVANIA SALT MFG. CO., Philadelphia, Pa. American shield and attractive sign of salt crystal. Replica of Bunker Hill monument, cast of ammonium sulphate. Chlorine and alkali. Model of Wedge furnace.

PFAUDLER CO., Rochester, N. Y. Enameled, jacketed mixing tank with removable cover, also one-piece closed tank; kettle with new type of adjustable agitator; closed storage tank and pots in several shapes.

PHILADELPHIA QUARTZ CO., Philadelphia, Pa. Silicate of soda. In charge of exhibit, James G. Vail, Edward Quintard, W. H. Buxton, J. B. Mercier.

PNEUMERCATOR CO., INC., New York. Indicating instruments for measuring depth, weight or volume of any liquid contained in any tank, stand pipe or reservoir. Instrument can be located at any distance from tank. Displacement indicator for ships, automatically indicating cargo and displacement. Gasoline gage for automobiles or aeroplanes. In charge, A. C. Kohl.

PRATT ENGINEERING & MACHINE CO., Atlanta, Ga. Regulus metal and aluminium exhausters for handling corrosive gases. Acid valves and blow boxes. Photographs of various sulphuric and fertilizer plants designed, constructed and equipped by exhibitor. Photographs of standard machinery and apparatus for chemical and fertilizer plants. In charge of exhibit, C. A. Murphey.

PRECISION INSTRUMENT COMPANY, Detroit, Mich. Boiler control apparatus. 1. Complete gage board for boiler control, having two 3 in 1 gages indicating the draft through the ashpit, combustion chamber, flue before the economizer, after the economizer, and the last pass; steam gage indicator, steam gage recorder, CO_2 recorder, steam flow meter, flue gas temperature recorder, rheostat control valve, remote control switches. 2. Gage board showing complete line of "U" gages, 2 in 1 recorder, 2 in 1 indicator, combined indicating and recording differential gage. 3. CO_2 analyzing machine for recorder on the board, 406C CO_2 recorder, standard type. 4. Gas collector, Orsat type, efficiency kit. 5. Chemical lamp blown glassware. In charge of exhibit, A. T. Baldwin, pres. and mgr., Detroit; Vincent & Gibson Engineering Corp., 30 Church St., New York City.

PRECISION THERMOMETER & INSTRUMENT CO., Philadelphia, Pa. Precision engineer type separable socket thermometer for power and process plants, built to meet the specifications of the Bureau of Steam Engineering, U. S. N. Technical thermometers of all descriptions, thermometers for laboratory and research work, thermometers and hydrometers for acid manufacturers. Pentane and toluol thermometer, made in Philadelphia, for low temperatures. Toluol to minus 100° C.; Pentane to minus 200° C. Precision Le Boulengé chronograph for determination of muzzle velocity of a projectile. Precision calender micrometers, indicating and recording. Standard mercurial barometer, built to U. S. Government specifications. Meteorological instruments. Precision hydrometer for all purposes. In charge of exhibit, Lewis G. Wilson, L. L. Stewart, H. L. Balderston.

PREST-O-LITE CO., Indianapolis, Ind. Gas tanks and appliances, acetylene, welding outfits, etc.

PROCESS ENGINEERS, LIMITED, Montreal, Canada. Model showing a complete installation for diluting rosin sizes, soluble oils and other emulsifying materials. Also a working-size emulsifier and samples showing the permanent character of solutions produced by this process. In charge of exhibit, J. A. DeCew, H. A. Radford and Robert B. Best.

PRODUCTS SALES CO., Baltimore, Md. High acid resistant asbestos and industrial minerals. In charge of exhibit, H. Hanna, F. A. Nielt.

PROVOST ENGINEERING CO., New York. Provo metal and wooden filter presses.

PYROLECTRIC INSTRUMENT CO., Trenton, N. J. Pyrometers and electrical precision instruments. Considerable attention was drawn to the Northrup-Ajax high frequency induction furnace, which was developed by E. F. Northrup for and with the financial support of the Ajax Metal Co. of Philadelphia, Pa. The new Northrup tin pyrometer also attracted great attention.

QUIGLEY FURNACE SPECIALTIES CO., New York. Demonstration of hytempite furnace cement, showing its heat-resisting qualities.

RAYMOND BROS. IMPACT PULVERIZER CO., Chicago, Ill. Exhibited pulverizing and air-separating machinery used for producing fine ground materials of all kinds. Also exhibited a few air-separated products; that is, samples of materials as they are fed to air mills and the powdered material produced. The Raymond System is a complete unit for taking materials around one-inch size and reducing them to a powder having any fineness desired and in one operation. It takes the place of grinding, elevating and screening machinery and is dustless in operation. In charge of exhibit, C. M. Lauritzen, vice-pres. and mgr.; W. M. Cook, Joe Criter, W. A. Koren.

RESEARCH CORPORATION, New York. Display of high-voltage, direct-current, generating equipments. 1. Mechanical rectifier. 2. Kenotrous (General Electric Co.). 3. Girvin high-voltage, direct-current generator. Demonstration Cottrell collector for smoke fume and dust. Display of samples of materials. Precipitated by the Cottrell electrical precipitation processes. In charge of exhibit, H. D. Egbert, commercial department; P. E. Landolt, engineering department.

RESEARCH LABORATORY OF CHICAGO. Pharmaceutical chemicals, dyes and intermediates, the processes for the manufacture of which have been developed in their laboratory. Among the products exhibited are methylene blue, dye and medicinal; phenacetin, phenolphthalein, dimethylglyoxime, para amido phenol, para nitro phenol, malachite green, benzoic acid, beta naphthol benzoate, benzoyl chloride, hydroxylamine hydrochloride and ethyl nitrate. In charge of exhibit, H. McCormack, S. W. Kendall.

THE ROESSLER & HASSLACHER CHEMICAL CO., New York. Showed sodium cyanide, 96 to 98 per cent, cyanide-chloride mixtures—copper cyanide, silver cyanide and zinc cyanide for plating; also the plating salts, silver, copper, zinc and gold trisalyt. In charge of exhibit, William J. Schneider.

RUGGLES-COLES ENGINEERING CO., New York. Model of double-shell, direct-heat dryer. A working duplicate of regular machines. In charge of exhibit, F. E. Finch, W. H. Glomb.

RUTH FLOTATION MACHINE CO., Denver, Col. Ruth testing machine for laboratory testing purposes. Exact duplicate of commercial machine. Joseph P. Ruth, Jr., in charge.

SCHAAR & CO., Chicago, Ill. Laboratory apparatus, chemical glassware, "Hexagon" oil tester, "Hexagon" heater, "Hexagon" Harvard trip scale. Universal electric heater. All standard makes of glassware, porcelain, filter paper, etc. Adolph E. Schaar in charge.

THE SCHAEFFER & BUDENBERG MFG. CO., Brooklyn, N. Y. Indicating gages and recording gages, gage testers. Indicating thermometers of all types, recording thermometers. Counters of all types. Indicating, portable and recording tachometers. In charge of exhibit, R. Wimmers, A. Weiss, F. Undeutsch.

SCHAUM & UHLINGER, INC., Philadelphia, Pa. Cantilever suspended bottom-discharge centrifugal dryer.

SCHUTTE & KOERTING CO., Philadelphia, Pa. Apparatus for handling acids and other chemical liquids, gases and vapors; comprises lead valves, lead-lined valves, lead exhausters, both with water and steam as the motive power. Double tube injectors, steam syphons, various types of spray nozzles and spray equipment. The Bihn Jones automatic apparatus, air jet lifts, and a full line of oil-burning equipment, heaters, etc. In charge of exhibit, C. H. Kimberly and J. S. Patten.

SCIENTIFIC EQUIPMENT CO., New York. Exhibiting the apparatus made by Central Scientific Co. of Chicago, de Khotinsky constant temperature baths and ovens, balances, air pumps, rheostats, American glass and porcelain ware, and the laboratory furniture of the Kewaunee Mfg. Co., makers of chemical desks, hoods, cabinets, etc. In charge of exhibit, O. T. Louis, S. L. Redman, Chas. Ress, C. G. Campbell

ERNEST SCOTT & CO, Fall River, Mass. Chemical process machinery, photographs of installations.

SEYDEL MFG. CO., Jersey City, N. J. Textile sizings, benzoic acids, fur colors and special chemicals.

SHARPLES SPECIALTY CO., Philadelphia, Pa. Several types of centrifugal machines.

SHRIVER & CO., Harrison, N. J. Shriver standard filter press and Atkins-Shriver type O patented filter press.

SIDIO COMPANY OF AMERICA, New York. Fused silica tubes, coils, crucibles, concentration dishes and special apparatus.

JOHN SIMMONS CO., New York. Steam and mechanical specialties. Leinert automatic gravity scales for liquids. Acid-proof valves and high pressure fittings.

WALTER SODERLING, INC., New York. Dustite respirator.

SOUTHERN RAILWAY SYSTEM. Mineral and chemical resources of the South, manganese ore, bauxite oils, tars, talc, soapstone, barite, raw and finished products. In charge of exhibit, J. H. Watkins, W. C. Olds.

SOWERS MFG. CO., Buffalo, N. Y. Seamless one-piece jacketed kettles, vacuum pans and mixers.

E. R. SQUIBB & SONS, New York. Organic and pharmaceutical chemicals.

STAMFORD EXTRACT MFG. CO., New York. Samples of logwood extracts and yarns and leathers dyed by these dyes.

ST. GEORGE CHEMICAL CO., New York. Rubber, paper and leather, manufacturers' chemicals, antimony, sulphide, heavy calcined magnesia, whiting and various colors. In charge of exhibit, J. G. Smith, H. C. Bugbird, D. S. Naugle, R. J. Parkellt.

ST. LAWRENCE TALC CO., New York City. Talclay for obtaining vitrified bodies at a lower cone, using 5 per cent with regular body mix.

STEVENS-AYLSWORTH CO., New York and Toronto. Demonstration of agitators and mixers for liquids and dry products. In charge of exhibit, Messrs. R. G. Stevens, W. N. Stevens, R. P. Alysworth

F. J. STOKES MACHINE CO., Philadelphia, Pa. Pharmaceutical and chemical machinery and apparatus. Tablet making machine in operation. Vacuum drying machinery, automatic water still, etc. In charge of exhibit, Lawrence H. Bailey, Charles F. Coleman.

STUEBLING LIFT TRUCK CO., Cincinnati, Ohio. Factory trucks.

STURTEVANT MILL CO., Boston. Crushing, grinding, pulverizing, screening, mixing (dry), weighing and sacking, and elevating machinery. In charge of exhibit, L. H. Sturtevant, H. A. Tomlinson, W. T. Doyle, D. Kantor, H. P. Withington.

SWENSON EVAPORATOR CO., Chicago, Ill. "The sign of the kettle."

TAKAMINE LABORATORY, INC., New York. Polyzime "T" and "L", Japanese chemicals, potash, salts.

TAYLOR INSTRUMENT CO., Rochester, N. Y. Tycos recording thermometers, industrial indicating thermometers, pyrometers, and temperature regulators. A new development was shown in the Tycos multipyrograph for recording six different temperatures on one chart, employing only one galvanometer. In charge of exhibit, H. W. Maurer, James Ely, A. J. Nelson, H. W. Kugler, D. C. Day, Jr., Fred K. Taylor.

TENNESSEE COAL, IRON & R R. CO. Iron ore and by-products. Coal and by-products.

THE TEXAS CO., New York. Petroleum products.

TEXAS, STATE OF. Petroleum and its products, mica, minerals, sulphur. In charge of exhibit, F. E. Pye, W. D. Bettis, Seaton Keith, J. R. McNeil, Milton Everett, H. L. Hargrove.

TEXTILEATHER CO., New York. Textile leather substitutes.

TEXTILE COLORIST, Philadelphia, Pa Reception booth Library of bleaching, dyeing and finishing.

TEXTILE WORLD JOURNAL, New York. Bragdon, Lord & Nagle Co., Textile Publishing Co. Reception booth.

THE THERMAL SYNDICATE, LTD., New York. This display covered vitreosil (fused pure silica) concentration, condensation and cooling plant for sulphuric, nitric and hydrochloric acids, etc., also laboratory ware, drawn tubes, moulded pipe and other forms of apparatus for the chemical and allied industries. The exhibit included retorts of 75 and 50 litre capacity, tubes 4½ in. and 4¼ in. internal diameter, pipe 15 in. internal diameter and "S" Bend coolers 8 in. internal diameter. Special attention was called to the installation at the Davison Chemical Company plant, Curtis Bay, Maryland, where the final concentration of 180 tons of sulphuric acid daily is carried out exclusively in Vitreosil units. In charge of exhibit, E. A. Haynes, S. L. Tyler, E. J. Van Vranken, W. W. Winship.

THWING INSTRUMENT CO., Philadelphia, Pa. High resistance, multiple record pyrometers.

TOCH BROTHERS, New York. DUREX CHEMICAL CO., Sweetwater, Tenn. Technical paints, water proofing compounds, damp proofing paints, enamels, cement colors, rust inhibiting and protective paints, varnishes, chemical dryers and Japans. Barium products of all kinds, colors, chemicals, etc. In charge of exhibit, Archibald C. Reid, advertising manager; G. H. Benkhardt, sales manager; V. P. Krauss, fectory superintendent.

TOLHURST MACHINE WORKS, Troy, N. Y. Several interesting types of centrifugal machines.

TRADE NEWS SERVICE, New York. Reception booth.

UEHLING INSTRUMENT CO., New York. Uehling CO2 recorders for increasing combustion efficiency, and other instruments.

UNITED FILTERS CORPORATION, Brooklyn, N. Y. One American continuous suction filter in actual operation, showing cake building characteristics and method of discharging solids. One Sweetland filter in actual operation, showing filtering characteristics of Sweetland's Patent Metallic Cloth. Small practical units of Kelly type filter and Sweetland Clam Shell type filter also on exhibition. Complete line on all the various types of filter leaves and filter cloths furnished by the U. F. Co. on hand. In charge of exhibit, Arthur Wright, H. J. Runyon, Jr., T. L. Geuter, H. W. Schmidt, M. J. Jackson, R. Cottrell.

UNITED GAS IMPROVEMENT CO., Philadelphia, Pa. Samples of coal tar product, tar naphthalene, sulphate of ammonia, phthalic anhydride, etc.

UNITED LEAD CO., New York. "United" lined acid pipe and fittings.

U. S. CAST IRON PIPE & FOUNDRY CO., Burlington, N. J. Display of "Usicast" chemical castings and U. S. cast-iron pipe. Included a cast-iron pipe line showing various thicknesses and types of joints of U. S. cast-iron pipe. Also several reproductions of "Usicast" equipment. H. A. Hoffer of the chemical castings department in charge.

U. S. DEPT. OF AGRICULTURE. Fertilizers and photographs of processes.

UNITED STATES MAGNESITE CORPORATION, New York. Showed magnesite from their mines in California and Washington and ranging through the different manufactured products, such as caustic magnesite, dead burned magnesite, ferromagnesite, down to the common Epsom salts, also a product of magnesite. Also showed a new polish for all kinds of metals, glass, etc. In charge of exhibit, F. E. Schundler, Karl K. Kennedy, George H. Nielson.

U. S. SMELTING CO., INC. Commercial samples of lead, electrolytic, common and antimonial, copper, spelter, electro and high grade, selenium, cadmium, bismuth, arsenic. Full size gold and silver bars. Platinum and palladium. A new departure in exhibits in that the arrangement of shelves and equipment is permanent and the property of the exhibitor. The whole can be removed from place to place. A beautiful example of bismuth crystals shown. In charge of exhibit, Sidney Rolle, Don Irions, B. B. Hood and Joseph Clark.

UNIVERSAL FIBRE CO., Trenton, N. J. Fibre barrels.

VALLEY IRON WORKS, Williamsport, Pa. Reception booth.

H. VAN EMDEN & CO., New York. Tanks, pans, stacks, kettles and plate work. Quick delivery. Sales agencies In charge of exhibit, H. Van Emden, M. I. Dorfan.

VISCAMITE CO., New York. Samples of viscamite, a

patented vegetable glue for all purposes where animal glue is used.

WALLACE & TIERNAN CO., INC., New York. Demonstration of chlorine diffusor in operation. Exhibit of chlorine control apparatus.

WAL PHOTO CO., New York. Official photographer of the exposition.

WARNER CHEMICAL CO., WARNER-KLIPSTEIN CHEMICAL CO., New York. Exhibit, Nelson electrolytic cell. Chemicals: Acetic anhydride, acetyl chloride, acid phosphoric, aluminum hydrate, calcium phosphate monobasic, carbon bisulphide, carbon titrachloride, phosphorus trichloride, phosphorus oxychloride, soda caustic liquid, soda caustic solid, sodium phosphate monobasic, 100%, sodium phosphate monobasic pyro, sodium phosphate dibasic com'l, sodium phosphate dibasic U. S. P. tran., sodium phosphate dibasic, U. S. P. anhyd., sodium phosphate tribasic, sulphur chloride.

WARREN, WEBSTER & CO., Camden, N. J. Metering Feed Water Heater. The apparatus shown in actual operation is the well-known Webster-Lea heater meter. It consists of a standard Webster open feed water heater combined with a genuine Lea V. Notch Weir meter to form one unit. The outstanding features are that heater and meter are independent units, so arranged that either can be operated independently or in combination as desired. The flow of water to the meter is controlled by a float-actuated valve in strict accordance with boiler feed requirements, so that the meter cannot flood. Extra large pump storage is provided. Webster oil and steam separators, expansion joints and heating system specialties are also shown. In charge of exhibit, W. F. Bilyeu and G. A. Binz.

WELDING SUPPLY CO., New York. Welding and cutting apparatus, oxy-acetylene, oxy-thermalene, thermit electric welding apparatus.

WERNER & PFLEIDERER CO., Saginaw, Mich. Universal kneading and mixing machines for chemical and allied industries. Photographs of installations.

WESTINGHOUSE ELECT. & MFG. CO., East Pittsburgh, Pa. This company exhibited apparatus of their line that is used in the chemical industry. This includes motors, starters, oil switches, circuit breakers, meters and transformers. A line of laboratory apparatus is also shown. This includes electric stoves, hot plates, water heaters, fans and air purifiers. A number of Bakelite Micarta gears are shown. Bakelite Micarta is the only non-metallic gearing material that is self-supporting and in most cases neither bushings nor flanges are needed. A Thury regulator is shown. This regulator regulates the temperature of electric furnaces automatically.

WEST TEXAS MICA CO., Houston, Texas. Mica products.

WHITALL-TATUM CO., New York. Chemical glassware and rubber goods. In charge of exhibit, W. W. Figgis.

WILLIAMSBURG CHEMICAL CO., INC., Brooklyn, N. Y. Sulphur black, malachite green, auramine, benzyl chloride, benzol chloride, benzaldehyde, benzoic acid, U. S. P., benzoate of soda, U. S. P., dinitrochlorbenzol, permanganate of soda. In charge of exhibit, Charles L. Hirsh.

ZAREMBA CO., Buffalo, N. Y. Reception booth and photos of Zaremba evaporators.

Industrial Handicaps in Switzerland

The Department of Commerce has issued a bulletin covering the industrial situation in Switzerland, which gives interesting information regarding the effect of the war upon Swiss chemical and metallurgical industries during the last year.

COAL SUPPLY AND PRICES

The shortage in the coal supply became manifest in September, 1916. A committee, with its chief office in Basel, was established to arrange for fuel from Germany and the occupied Belgian districts. An agreement was reached by which Switzerland was to receive 253,000 metric tons of coal and coke monthly—50,000 for railways, 7,000 for sidings, 51,000 for gas works, and 145,000 for domestic and industrial purposes; but in reality the full quantity agreed upon was never delivered.

The retail prices of fuel per metric ton steadily rose from $12.50 in January to $17.25 in December for Belgian coal, while coke increased from $11.20 to $16.60.

RAW MATERIAL FOR SWISS METAL INDUSTRIES

In 1916 material improvement was shown in the Swiss metal industries. The various orders placed with Swiss firms were carried out with fewer difficulties and, owing to the absence of German competition, prices for the finished products were satisfactory. Machine tools were in heavy demand.

Through a commercial agreement with Germany, Switzerland hoped to relieve its economic difficulties, but did not succeed because German consignments of steel and iron were long delayed, despite contracts for immediate delivery. Representatives then obtained satisfactory supplies from the United States, but many transportation handicaps were experienced. The prices per short ton were:

	Dec., 1916	Normal Price
Scrap iron	$70-$88	$12-$14
Steel	$122-$176	$32-$39
Pig iron	$35-$53	$12-$14

The German Steelworks Association, through a central office, canceled the mark currency, fixed a standard for the franc, and voided Swiss contracts causing a 60 per cent price increase. No pig iron could be imported from Germany from July to November, when the United States became the principal country of supply. Tin came from Germany until June, 1916, after which shipments declined and prices increased 300 per cent. The price of electrolytic copper advanced from 24½ cents in January to 38 cents in July, receding to 33½ cents in December.

The manufacturers of ammunition depended entirely upon the country's resources for acids, which were hardly sufficient. The fair supplies of hydrochloric, sulphuric, and nitric acids relieved the shortage of other materials and kept the factories in operation.

ANILINE COLORS AND ARTIFICIAL INDIGO

There was a decrease in aniline exports to the United States in 1916 amounting to 6 per cent, and an increase in value of 113 per cent. This was due to the general advance in prices and to the exclusive shipment of the finer and more expensive colors. The progress made in the American color industry practically excluded the lower grades of Swiss dyes from that market. Anxiety was felt in Switzerland concerning the future trade in Swiss colors with both the United States and England. The belief that those countries would not be able to produce aniline dyes was disproved. Since 1914 dye factories have also been built in France, Italy, and Russia. It became more and more difficult in 1916 to obtain necessary raw materials from England and the United States. The Swiss manufacturers are now preparing to withstand the apparently concerted effort of German color manufacturers to undermine them.

The quantity of artificial indigo exported to the United States in 1916 declined by 212,521 pounds, but was valued at $150,229 more than that shipped in 1915. That there was an actual increase in value is unlikely, but the new tariff law making this color dutiable compelled the manufacturers to state the market value, whereas formerly, under free entry, they gave only nominal values in their invoices. The decrease in quantity should probably be attributed to the activity of the British firm of Elesmer Port.

The Russian Market, Its Possibilities and Problems

By A. J. Sack
Director, Russian Information Bureau.

The present war and the Revolution undoubtedly opened a new era in Russian industrial development, and there is no question but that by a proper and active policy the United States will share largely in this development in Russia.

Russia needs the help of American capital and business enterprise in her economic development. The United States, with a surplus capital and with a steadily increasing industrial production, requires the immensely large Russian market as an outlet for its trade and its investment. The two countries are in a splendid position to supplement their respective economic requirements.

The present war has created many changes in the prospects for the development of a close economic co-operation between Russia and the United States, but even prior to the war there is strong evidence showing the tendency toward economic co-operation between Russia and the United States. The changes effected by the present war are therefore only an emphasized continuation of the natural tendency toward an American-Russian economic rapprochement.

The United States export to Russia always has been greater than Russia's export to the United States. By comparing the Russian and the United States statistics referring to the United States export, the following table is obtained:

Years	U. S. Export to Russia According to U. S. Statistics	U. S. Export to Russia According to Russian Statistics
	(Yearly average in millions of dollars)	
1878-1890	11.9	15.5
1891-1900	7.5	22.0
1901-1910	16.7	28.3
1911-1913	25.4	42.3

In this table preference must be given to the Russian statistics. A great part of the goods en route from the United States to Russia was frequently reloaded in west European ports and therefore appeared in the United States statistics as export to Germany, Great Britain or Holland. "The United States is playing a greater part in our trade," says the official report of the Russian Ministry of Finance, "than can be seen in our statistical reports. The real amount of our trade with the United States is not obvious, on the one hand, because of our undeveloped direct trade relations, and on the other hand, because of the middleman's part, played until now by Germany and Great Britain."

This official Russian statement can be reversed to interpret the American side of the situation. Russia is playing in the United States trade a considerably larger part than can be seen in United States statistics.

The two countries have need of one another, and, therefore, trade between them developed even under the most adverse circumstances. It is impossible to say what was the real amount of American-Russian trade, but assuredly considerable quantities of Russian goods were successfully brought into this country and great quantities of American goods were successfully brought into Russia.

GOODS NEEDED IN THE UNITED STATES IMPORTED FROM RUSSIA

Russia supplies the United States almost exclusively with raw materials. In 1910 Russia's entire export to the United States, according to Russian statistics, amounted to 4.84 million dollars. Of this, 4.69 million dollars—about 97 per cent—was raw materials. Such products as hides and skins, wool, horse manes, horse tails and bristles hold first place among these exports. Russian statistics accredit these goods with a yearly average of 2.22 million dollars for the period 1906-1910 out of 3.82 million dollars of Russia's entire export to the United States.

Second place should be given to licorice root. It is of interest to observe that the United States is almost the sole market for Russia's licorice root. In 1910, out of 29.24 million pounds of Russia's total export of licorice root, 27.73 million pounds were exported to the United States.

Besides the products mentioned above, it is necessary to call attention to Russia's export of rubber waste, manganese ore, flax and hemp. According to United States reports, the export of these goods to the United States was greater than the Russian statistics show. During the period 1906-1910 the United States import of rubber waste averaged 4.83 million pounds, according to Russian statistics, and 6.53 million pounds according to the United States reports. As for manganese ore, Russia reported 24.3 million pounds and the United States reported 30.4 million pounds. The most noteworthy difference is found in the statistical reports relating to Russia's export of flax and hemp. According to the Russian statistics, the yearly average of Russia's flax exported to the United States during the period 1906-1910 amounted to 481,100 pounds. According to the United States statistics, it amounted to 6,786,000 pounds. The corresponding figures for hemp are 241,800 pounds in Russian statistics.

According to the statistics of both countries, therefore, during the ten years previous to the present war there has been a remarkable increase in the exportation to the United States of Russian raw materials consisting chiefly of licorice root, hides and skins, furs, hair and bristles, wool, hemp, horses' manes, horses' tails, pulp and rubber waste. The American statistics show also that a considerable amount of flax and flax tow must be added to this list.

During the war, on account of the restrictions placed by the Russian Government on the movement of Russian raw materials to the United States, it has been difficult to secure a free importation from Russia to this country. There has been, however, a very steady increase in the demand for Russian raw materials of all kinds. This is particularly true of furs and fur skins, of hides and skins, especially calf skins and goat skins, and also of Russian seeds. A typical illustration is the fact that prior to the war the United States purchased most of its sugar beet seed for planting purposes in Germany. Germany in turn secured the bulk of this seed from Russia. Since the war direct relationships have been opened and the United States has imported large quantities of Russian sugar beet seed. Careful estimates show that there is a market demand in the United States for from 60 to 75 million dollars' worth of Russian raw material, which forms a nucleus for a

large reciprocal trade with America, and to some degree discounts the idea that the trade between the United States and Russia is not supplemental in nature.

GOODS NEEDED IN RUSSIA IMPORTED FROM THE UNITED STATES

As to the United States export to Russia, there is again a great difference in the Russian and the United States statistics, relating not only to trade totals, but to individual articles of trade.

Cotton holds first place in the United States export to Russia. It has been noted before that the amount of cotton exported to Russia by the United States in 1910, according to statistics on this side, was 38.89 million pounds, whereas Russia reports 164.95 million pounds. And undoubtedly, even Russian statistics do not cover the entire amount of cotton coming originally from the United States.

Machinery and technical supplies hold second place in the United States export to Russia. And here special mention must be given to agricultural machinery and implements. During 1901-1905, according to Russian statistics, the entire United States export of machinery to Russia amounted to 3.23 million dollars, yearly average; of this 2.73 million dollars covered the United States export of agricultural machinery and implements. Reports for the period 1906-1910 give 4.94 million dollars as the entire machinery export, of which 4.43 million dollars covers the export of United States agricultural machinery and implements to Russia.

It is interesting to note that in the United States statistics relating to the export of agricultural machinery and implements to Russia, larger figures are given than those above. Reports on this side give 3 million dollars as the annual average for the period 1901-1905, as against the 2.73 million dollars quoted by the Russian reports. Corresponding figures for the period 1906-1910 are 5.17 million dollars, according to American statistics, and 4.43 million dollars, according to Russian reports. For 1913 there is 5.31 million dollars according to the United States statistics and 4.7 million dollars according to Russian reports. It is natural to expect the Russian figures to be higher than the American, because the Russian estimate is a combined estimate of the price in the American port plus freight, insurance, loading expense, and even often including the profit of the west European middleman. The report of the Russian Ministry of Finance explains the situation very clearly. "Part of the American machinery," says the report, "after being reloaded in Germany, England or Denmark, is registered in our statistics as coming from these countries and not from the United States."

The same may be said about copper, which holds third place among the goods imported in Russia from the United States. According to Russian statistics, the United States copper imported averaged yearly 8.88 million pounds during 1901-1910. On the other hand, according to the United States statistics, the amount was 18.52 million pounds. It is seen that the amount of United States copper that entered Russia, according to American statistics, was more than double the amount given in Russian reports. The Russian Ministry of Finance gives again a very definite explanation of the situation. "We receive United States copper," says the report, "through Germany's and Great Britain's hands."

A remarkable discrepancy occurs further in the statistics relating to United States flour imported in Russia. According to Russian statistics, the yearly average import of United States flour of every kind, excluding potato flour, during the period 1906-1910 amounted to 15.7 million pounds. On the other hand, according to the United States statistics, the yearly average export to Russia of only wheat flour for the same period amounted to 75.81 million pounds. The flour is exported mostly to Finland, and because of the lack of direct connections with the United States it is registered in Finland as brought from Germany. This fact has been mentioned more than once even in the German official reports.

The following table shows the growth of the United States export to Russia before the war, according to United States statistics:

U. S. Yearly Average Export to Russia (In Thousands of Dollars)

	1891-1895	1896-1900	1901-1905	1906-1910	1911-1913
Cotton (raw)	4,811.0	3,006.0	5,909.0	5,478.0	5,685.5
Agricultural machinery and implements	323.4	684.4	3,000.0	5,178.0	7,729.7
Copper (unmanufactured)	....	822.0	1,632.0	1,112.0	1,322.7
Wheat flour	136.0	395.0	773.0	1,895.0	3,360.0*
Leather (prepared)	....	1.3	1.8	162.0	1,075.3**
Machine oil and paraffin	1.8	9.1	71.1	151.2	232.8**
Rosin	241.0	285.0	275.0	320.0	737.0
Typewriters	....	126.1	172.7	367.8	846.9
Cash Registers	....	....	26.0	124.0	249.4**
Sewing machines	....	28.1	36.3	232.9	768.3**
Scales of every kind	29.4	70.5	54.0	57.0	58.6**
Twine, cord, etc	11.7	28.5	299.9	753.0	1,646.4

The figures just quoted, together with the figures quoted previously regarding Russia's export to the United States, show quite clearly along what lines the American-Russian trade rapprochement had begun to develop even before the war, before the remarkable changes produced in the economic situation of both countries.

Russia supplies and will supply this country with raw materials of the highest quality. The amount of Russian raw materials brought to this country is much greater than can be seen from Russian or even United States statistics. By creating direct connections with Russia, by careful study of the conditions of the Russian market, by an active trade policy, the amount of raw materials brought to the United States from Russia can be multiplied many times to the benefit of both countries.

On the other hand, the United States supplied and will supply Russia with all kinds of machinery, with all kinds of products that presuppose a highly developed industrial culture. The possibilities of such trade, very apparent before the war, are emphasized by the events of the war. Germany, which in 1913 held 52.6 per cent of all Russia's import, is now withdrawn from the field. By proper and active policy the United States can now not only develop that line of her trade with Russia that showed a natural tendency to develop before the war, but even introduce into the Russian market a full line of goods never before brought into Russia from the United States. It is indeed, a big opportunity.

Woolworth Building,
New York City.

* This is the figure for 1911. No figures are given for 1912 or 1913.

** Figures for 1913.

Production of Potash During First Six Months of 1917

More potash has been produced during the first six months of 1917 than was made during the entire year 1916. The reports received by the U. S. Geological Survey have been reduced to terms of the commercial unit commonly used to measure the available or water-soluble potash (K_2O) in the product, and only material actually sold by the producer during this period is included. The weight of the materials handled was therefore much greater than represented by these figures.

SUMMARY OF THE PRODUCTION OF POTASH IN THE UNITED STATES, JANUARY TO JUNE (INCLUSIVE), 1917

Source	Available Potash (K_2O)	Value at Point of Shipment
	Short Tons	
Natural salts or brines	7,749	$2,808,240
Alunite and dust from cement mills and blast furnaces	1,867	746,576
Kelp	2,143	1,348,095
Distillery slop, wool washings, and miscellaneous industrial wastes	2,153	876,714
Wood ashes	a111	84,414
	14,023	$5,864,039

a Only 25 reports of production from wood ashes having come in, some of the larger producers not having made returns.

This table includes practically all potash produced.

The Nebraska alkali lakes still lead, having yielded about one-third the entire production. There are now at least four important operators in this field.

The production from Searles Lake, Cal., would undoubtedly be materially assisted by passage of the legislation now before the House of Representatives dealing with the leasing of potash-bearing lands. Continued uncertainty as to the status of titles to this property has hampered development of this important deposit.

No production is reported from feldspar or other silicate rocks, but considerable quantities of potash salts and potash-bearing fertilizers were obtained from the dusts in cement mills and blast furnaces.

The production from kelp was about 15 per cent of the total, as it was in 1916.

Potash from distillery slop and other organic sources made 15 per cent or more of the total.

The production of potash from wood ashes, including "first sorts," "pearlash," and other grades, is supposed to have been much greater than it was in 1916, but reports from these producers have been much delayed and the figures obtained thus far are probably not representative. The potash made from wood ashes thus far reported amounted to 222 tons, which is assumed to average at least 50 per cent K_2O. This is perhaps too low, but definite information as to the grade of this material is difficult to obtain.

The prices quoted range from $3.50 to $6 a unit, a unit meaning 1 per cent of potash (K_2O) in a ton of the material as marketed—that is, a product carrying 25 per cent K_2O may be sold at $4 a unit, which would be $100 a ton for the material marketed.

The figures given seem to indicate that the production for 1917 will exceed 25,000 tons of potash (K_2O), or two and one-half times that made in 1916. This is about 10 per cent of the average normal yearly consumption of the country before the war, showing the need of further stimulating domestic production of potash.

Potash from Alunite

Fertilizer containing water soluble potash is being made from Utah alunite at the present time by the Mineral Products Co., St. Marysvale, Utah, who, together with the Utah Potash Company, were among the first to investigate the possibilities of the production of potash from alunite.

Roasted alunite can be used direct as a fertilizer, in fact, raw alunite also can and has been used. Roasting increases the potash content to about twice that of the unroasted material, by driving off the sulphur, hence a great saving in freight is made by roasting.

The Utah Potash Company is planning to go further than roasting alunite, and has built a factory at Trenton, N. J., where a wet process will be carried out, producing refined potassium nitrate or other potassium salts, together with various by-products. The alunite will be brought in from Utah where considerable money has been spent in development work on the company's alunite deposits near Marysvale. The average potash content (K_2O) is 7 to 10 per cent. An analysis of the alunite made by Dr. H. J. Detwiller of Allentown, Pa., is as follows:

Silica	2.91
Alumina	35.32
Sesq. Ox. Iron	1.99
Phosphoric Acid	.40
Sulphur Anhy.	37.86
Potash	10.85
Soda	.26
Water	9.99

The material is brought in in sizes up to 12 inches. It is first put through a Blake style crusher from which it goes to a 10 or 12-inch traveling belt and from there to two Moser mills where it is reduced to $\frac{1}{2}$ x $\frac{3}{4}$ inches. It is then elevated to three Griffin mills where it is ground to 100 mesh. From there it is elevated to a bin, and then delivered to leaching tanks as needed. The tanks are used in series of three. In the first tank it is digested with water and acid, being heated with live steam. All of the material dissolves but the silica.

After filtering, the liquid is run into the second tank where the alumina is precipitated with an alkali potassium compound. The filtrate from the second tank goes to the third tank where the sulphuric acid is precipitated with barium carbonate, giving barium sulphate. The remaining solution containing the potash is then evaporated and the potassium nitrate crystallized out. The mother liquor is used over again.

The company will concentrate a great deal of attention on by-products when the process is in satisfactory operation. Some of the possible products are silicate of soda, alum, aluminium, barium salts, etc. The process has been worked out by Dr. H. J. Detwiller, consulting chemist, of Allentown, Pa., and Mr. T. F. Taylor, treasurer and mechanical engineer of the company.

Iron Ore in 1916.—The iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made, according to the U. S. Geological Survey. The shipments from the mines in 1916 were 77,870,553 gross tons, valued at $181,902,277. The quantity mined in 1916 was more by 19,600,000 tons than that mined in 1915.

Synopsis of Recent Metallurgical and Chemical Literature

Metallurgical Industries at Birmingham, England.—At the annual meeting of the Society of Chemical Industry in Birmingham, England in July, Prof. T. Turner of the University of Birmingham, reviewed the progress of the local metallurgical industries at Birmingham, during the war. Closely associated with the production of coal and iron in this district is the supply of refractories, and the manufacture of copper, brass, nickel, aluminium, and other metallurgical materials. He said the production of iron and steel in the Staffordshire district is limited by the moderate supplies of ore in an inland center. The output is, however, by no means negligible, and is equal to that of the whole of the United Kingdom a century ago. The basic process of steel manufacture is that which is chiefly followed, and the open-hearth furnace is taking the leading place here, as in other centers of the steel trade. The wrought iron trade, though much smaller in volume than in its palmy days, still flourishes, and all the local works have been fully employed at remunerative prices. The blast furnaces produce foundry forge and basic pig irons; the maximum output has been maintained, and it is proposed to put additional furnaces in blast.

In the brass and copper industries there has been unprecedented activity. Though no new scientific discoveries have to be recorded, many improvements have been introduced into works practice. Incidentally reference may be made to the extended use of town gas for melting purposes, with resulting increase of speed and economy. Tilting furnaces are now much more used than was formerly the case. An important local industry is that of cartridge manufacture. The results of researches conducted in the University of Birmingham, by Dr. O. F. Hudson, have been found of considerable value to local manufacturers, particularly in connection with the annealing of metals, and the composition and treatment of certain brasses which have recently had an extended application.

The local nickel industry has been taxed to its utmost capacity; not only has there been the unprecedented demand for cupro-nickel, but the nickel silver trade has been by no means idle, while there has been a demand for pure nickel goods such as were formerly imported from the Continent.

Professor Turner said that in no direction has there been greater expansion than in the aluminium industry. There are now several large aluminium foundries in the city, and the output of only one of these would be equal to that of the whole world a dozen years ago. The product has been largely used in connection with munitions of war, as in certain parts of shells; in aeroplane construction, and for many other purposes where strength and lightness are desired. The metal is now very generally melted by means of town gas as fuel. This has been found to be cheap, clean, and convenient. Melting is performed either in graphite crucibles, or very commonly in cast iron pots, which are preferably protected by a wash of inert material. Pure aluminium is very seldom used; the alloying metals include zinc, copper, and occasionally tin, nickel, manganese, or other metals. Researches in the properties of these alloys have been conducted, and so far as opportunities permit, are still in progress in the University laboratories.

Recently special attention has been drawn to the production of malleable cast iron, which is an industry which has long been associated with Walsall, Birmingham, and the intermediate district. There are at present some 90 firms engaged in the local trade, and many of these conduct their business on a relatively small scale. The process generally followed is the Réaumur, or European method, of more or less complete oxidation of the carbon, as contrasted with the American or "Black heart" process in which the carbon is precipitated as fine grained, or secondary, graphite. For the production of this malleaable cast iron the raw material employed is obtained from pure hematite ores, as it is usually considered to be important to have metal which is low in phosphorus and manganese. The demand for specially pure ores for other purposes has led to attention being directed to the question as to how far other materials can be employed to replace the purer cast iron hitherto used. It is known that good material can be produced even when 0.25 per cent of sulphur or phosphorus is present, though the details of the annealing process have to be modified somewhat to suit the kind of iron employed. The problem is how to introduce an iron of a somewhat different composition without disorganizing the work of the smaller manufacturers who depend largely upon old-established methods of working. No doubt in time the larger firms will be forced in this, as in other manufactures, to adopt scientific methods, including chemical analysis and accurate temperature measurement. If this should be the result of the present difficulties the whole industry will benefit permanently. It is generally rcognized that the trade is an important one; that it is capable of very considerable exension; and that it is upon the adoption of scientific methods that such extension (or extinction) will ultimately depend.

Cartridge Brass.—At the annual meeting of the Society of Chemical Industry in Birmingham, England, Dr. H. W. Brownsdon read a paper on cartridge brass. He said the term includes pure copper-zinc alloys containing 65 to 75 per cent of copper. Such alloys are specially adapted for the manufacture of cartridge cases where the properties of malleability, ductility, and strength require to be combined in such a manner as to facilitate working, and at the same time to produce a finished product which will withstand the shock of firing in rifle or gun.

In order to meet these conditions, the raw materials used, viz., copper and spelter, must be of the highest quality and purity. The copper should be equal to electrolytically refined, and practically free from lead, iron, bismuth, arsenic, antimony, etc., and should on analysis show 99.93 to 99.95 per cent copper. It is desirable to melt down cathode copper into ingots before use in the manufacture of cartridge brass. The spelter should analyze 99.9 to 99.95 per cent of zinc and be as free as possible from lead, iron, arsenic, etc. The two metals, together with a proportion of clean heavy scrap, are melted in crucibles, the molten metals thoroughly mixed and then poured into dressed cast iron ingot molds. A good cartridge brass should not show on analysis more than Fe 0.045 per cent, Pb 0.025 per cent, with traces of other constituents. The cast metal is by subsequent rolling and intermediate annealing reduced to a definite thickness, in which form it is termed finished strip.

The changes in physical properties that the metal un-

dergoes in passing from the ingot to the finished strip are shown by the following figures:

	Yield Point	Tensile Strength	Elongation	Hardness, Brinell
	Tons	Tons	Per Cent	
Ingot (chill cast)	6	16	60—70	60
Strip, hard rolled	Over 20	30—40	10—15	150—200
Finishing strip, annealed at 650 deg. C.	6	20—23	65—75	60

The annealing operations in the manufacture of cartridge brass are carried out at temperatures in the neighborhood of 650 deg. C. It is not uncommon practice to work at a higher temperature than this, say, 680 deg. to 700 deg. C. when annealing the metal in the thicker and heavier stages. By so doing, the time required for annealing is reduced. With thinner metal and products which more rapidly attain to the furnace temperature the 650 deg. C. temperature is more closely observed, the time required being determined by the form of the product to be annealed and by the type of furnace used for the annealing. In muffle furnaces worked intermittently, the time may be three-quarters hour, while in rotary worm-fed gas muffles, suitable for small articles, the time may not exceed five minutes.

Apart from the enormously increased demand during the past three years, there has been no development of interest. Output has largely dominated other considerations.

Firms already engaged in the manufacture before the war have increased their plant and developed the manufacture on pre-war lines. The conditions requiring close attention are:

(1) The chemical composition of the alloy.

(2) The casting of the molten alloy.

(3) The work to which the alloy is submitted during the mechanical operations.

(4) The annealing of the alloys between the mechanical operations.

What may be recognized as the theoretically best method may in practice prove too slow.

It has been difficult during the past years of intensive manufacture to pay the necessary attention to the economical side of the manufacture. From raw material to finished product in the case of cartridge brasses, the percentage loss of material through volatilization, oxidation and pickling amounts to several per cent. Some of this is recoverable and during the annealing process to some extent preventable. The chief improvement to be looked for in this direction is annealing in a non-oxidizing atmosphere. There is nothing new in the idea of preventing oxidation losses during annealing, but, as in numerous other matters, the war has impressed upon us the shortcomings of many pre-war methods.

With the withdrawal of sulphuric acid from use for pickling purposes, and its substitution by nitre cake solutions, the value of clean annealing as against dirty annealing has become much more emphasized, and in the future the bright annealing of all copper alloys should be aimed at.

The manufacturer finds no difficulty in obtaining metal of the purity demanded. In the details of working, the metallurgist knows exactly what he wants both as regards annealing temperatures and work that can be put on the metal. His difficulty is in securing that uniformity of treatment which ensures complete success.

Pyrometry is an essential aid, but its application to this class of work in bulk is still open to considerable improvement. The testing of the hardness of the products during manufacture and when completed is a matter of importance, and the method to be employed is best determined by the nature of the product to be examined. Both the scleroscope and the Brinell instrument are of value, and it is a matter of detail as to which is the more suitable. The fundamental conditions involved in the manufacture are the alternating production of strains by work and their release by annealing. The final product is commonly left in a more or less strained condition. As a means of determining the position and nature of the strains, the weakening of the metal by immersion in mercuric chloride solution, which allows the strains to develop visible cracks, is most valuable.

The success of the industry, therefore, lies in carrying out the manufacture under uniform conditions, which conditions should be governed by:

(1) Analytical control of the metals going into the pot.

(2) Analysis of the cast ingot.

(3) Correct distribution of mechanical work at the various stages of manufacture.

(4) Correct annealing checked by pyrometer, microscope and hardness tests.

Finally, a complete examination, both chemical, metallurgical and physical, of the finished product should be systematically made.

Mr. Alex. E. Tucker said that the heat at which the strips were cast was most important. Were they cast as hot as possible? Then, again, in regard to the manufacture of fine tube the author was emphatic on the point that he received virgin metals of a high grade, but he (the speaker) had often found that copper banding used on cartridges contained a quantity of arsenic. He agreed as to the value of the mercuric chloride test.

Dr. Brownsdon in replying to Mr. Tucker said they worked at the lowest pressure possible right through. It was not unusual to find traces of arsenic in certain kinds of copper. He had been able to trace trouble in cartridge brass to phosphorus. It arose from the scrap metal, and it tended to cause metal to crack when in a strained condition. In regard to the percentage of antimony the quantity was small, probably 0.06 to 0.07 per cent.

Iron and Steel

Hardening High-Speed Steel Tools.—A method of hardening which has been found most successful and economical is described by J. E. ROGERS in the *American Machinist* for Aug. 16, 1917. After experimenting with the carbonizing treatment, in which it was found difficult to regulate the thickness and uniformity of the skin, the following method was adopted, applicable to large and small tools. First, the tools are preheated to 1600 to 1700 deg. F. (the greater the cross-section of the tool the higher the temperature) in an overfired furnace in which oil is used as fuel and steam as the atomizing agent. This preheating shortens the time of the hardening heat which follows, and assures perfect and uniform assimilation of that heat.

The temperature of the hardening furnace, which is similar to the one used for preheating, depends on

the analysis of the steel, which must be known before any heat treatment is attempted. Steels of lower tungsten content harden at much lower temperature than those which contain higher percentages. Having worked with a great many brands of steel, the author finds that temperatures can be included within the limits of 1950 to 2300 deg. F. The correct temperature is essential, and the use of accurate thermo-couples is advised. The length of time of the hardening heat depends on the size of the tool, but should not be prolonged much beyond the time when the determined temperature is reached. Soaking at the hardening temperature may be necessary for the larger pieces, but should never be practiced on smaller, finer tools. The quenching medium is oil, of such character that prolonged use will not cause it to thicken. Tempering should be done at the maximum temperature, from 600 or 700 to 1000 deg. F.

The method can be carried out in any muffle furnace, using the front for preheating and the back for the hardening heat. Loss by this process has been negligible, and the results are the best obtained by any method.

Economizing high-speed steel by welding short tips of the material to shanks of machine or carbon steel has become a practice in many shops, due to the high cost of the high-speed steel. *American Machinist* for Aug. 16, 1917, describes two methods adopted for this purpose. In one case the electric butt welder is used, requiring a current of from 4 to 10 volts and 400 to 500 amperes. For lathe tools the tip of high-speed steel is from 1¼ to 3 in. long. A piece of tin is spot-welded over the joint of the two steel sections to hold them in alignment. The tool is then held in the jaws of the butt welder and the two pieces united. The time required is about ½ minute. For reamers, the tip of high-speed steel is about 2 in. long. For the annealing operations that follow the dressing of the joint the tools are put into an oven at 1600 deg F. for about 6 hours. They are then placed in lime to cool for from 7 to 10 hours. This operation is followed by the hardening process, in which the tools are heated to approximately 2200 deg. F., and quenched in kerosene or fish oil.

Oxy-acetylene welding also is practiced for the same purpose, the high-speed steel tips being clamped in a jig with the machine-steel shank. When the flame of the torch is applied to the joint to be welded the metals expand before the jig becomes heated, and are thus forced together. When the weld is completed the tool is removed from the jig and placed in powdered lime or bar sand to prevent chilling and the formation of hard, brittle spots in the weld.

Gold and Tungsten

Investigation of a Gold and Tungsten Ore in Idaho.—The recent demand for tungsten, and the high prices paid for the metal, led to the reopening of some mines in the Murray district, Idaho, which were reported to contain a gold-tungsten ore. Anticipating an interesting metallurgical study, R. R. Goodrich and N. E. Holden of the University of Idaho, investigated the mines and made experiments on the ore. While no gold-tungsten ore was discovered, a condition was disclosed which forms the subject of a paper by the investigators in the August *Bulletin* of the A. I. M. E., of which the following is a summary:

> "1. In the Golden Chest vein, the tungsten mineral, scheelite, occurs in rich segregations, in a more or less disturbed or distorted portion of the vein known as the tungsten zone, barren of gold and pyrite-free.
>
> "2. Since the tungsten mineral in the vein occurs in these rich segregations, a considerable portion of the ore is sacked in the stope and sent out to a cleaning floor, where it is brought up to a shipping grade by hand-picking.
>
> "3. In breaking down the ore in the mine, some fine tungsten mineral becomes mixed with waste rock and some pyritic material carrying small gold values. The tungsten mineral is recovered from this material (mill feed) by concentration.
>
> "4. Gravity concentration produces pyritic tungsten concentrates, 53.7 per cent WO_3, with high pyrite content. This is not a shipping grade.
>
> "5. The objections to flotation, as a means of purifying the pyritic tungsten concentrates, are: The purified tungsten concentrates are not sufficiently clean; there is considerable loss of tungsten in the overflow; and fine grinding is required.
>
> "6. The pyritic tungsten concentrates, when treated by roasting for magnetism followed by magnetic separation, yield purified $CaWO_4$ concentrates of shipping grade, WO_3 greater than 60 per cent, and sulphur less than 1 per cent. On all but the two finest sizes, the net recovery, expressed as per cent of WO_3 in the mill feed, is practically 90 per cent or greater, and on the two finest sizes, 76 to 83 per cent.
>
> "7. The investigation of the distribution of gold in the products is interesting only from a technical standpoint and not from a commercial. The profits must be derived from the output of purified $CaWO_4$ concentrates."

Copper, Lead and Zinc

The conservation of mill tailings for future treatment, with present enrichment and segregation as a preliminary step, is the subject matter of a timely paper by F. E. Marcy in the August *Bulletin* of the A. I. M. E. The author reviews the prodigal waste of mill tailings in earlier years, showing how anxious the managers were to get rid of such material by dumping it into streams or lakes where it would be out of the way. Butte, Coeur d'Alene, Flat River, Colorado and Lake Superior districts are cited as typical examples of such waste. At the present time mill tailings are impounded as a matter of necessity forced on many companies by laws against the pollution of streams, and as a consequence millions of tons of such material are available for future treatment. At the same time little discretion has been shown in the segregation of the more valuable from the valueless parts of such tailings, with the result that future treatment is made more difficult. The author enters a plea for segregation at the time the tailings are made, and suggests that this can be done with comparatively little expense and with great benefit for the future. Middlings not now profitable should be stored separately from general tailings, and oxide and carbonate products should be similarly separated from sulphides. Sand should be separated and segregated from slime, and the latter could be again divided into two products of different value. In general, tailings containing probable recoverable metals should not be stored over large areas in horizontal layers, nor should the first tailings of a process, which usually are richer than those made subsequent to improvements, be so placed that they will later be covered by valueless material. The cost of such segregation would be low at the time of initial milling, and should be charged to capital as a deferred asset and not to current operation.

Efficiency of Zinc-Dust Precipitation.—Among the papers offered for the St. Louis meeting of the American Institute of Mining Engineers in October is one on zinc-dust precipitation, by W. J. SHARWOOD, metallurgical chemist for the Homestake Mining Co. After discussing the history and principles of the process and the methods of its application, the author takes up the efficiency of precipitation.

"A precipitating efficiency of 100 per cent. assumes pure zinc, 1 atom of which should precipitate 2 atoms of silver or its equivalent in gold or copper from the double cyanide. At this rate 1 unit weight of zinc should precipitate 6.03 units of gold, 3.30 of silver, or 1.93 of copper, but in actual practice the results are much lower. Applied to commercial dust, the laboratory test usually shows an efficiency value of 30 to 60 per cent. Some extremely fine and pure 'artificial' zinc dusts, prepared by redistillation of spelter, have shown laboratory efficiencies of 75 per cent or more, and pure electrolytic zinc powder is claimed to be equally good. Otherwise the efficiency is generally higher when lead is present to the extent of a percent or two. Distinctly coarse or granular zinc preparations generally show very low results.

"Judged by the actual precious metal precipitated, the working efficiency on a large scale may be a mere fraction of 1 per cent in the case of low-grade gold solutions. A considerable amount of zinc is always wasted in side-reactions, such as the evolution of hydrogen, reducing dissolved oxygen, or precipitating copper and lead. With rich silver solutions the efficiency may approach 50 per cent, especially if no attempt is made to recover the last traces of silver.

"A practical example of mixed precipitation may be taken from the records of the Drumlummon tailing plant, covering three seasons, or twenty-four months of treatment of sandy tailing by leaching, the silver being largely in excess of the gold.

Sand treated	290,000 tons
Solution precipitated	390,000 tons
	Lb. Av.
Precipitate obtained	104,000
Zinc dust used	113,600
Metallic zinc dust	102,240
Zinc remaining in precipitate	40,300 = 39.4%
Zinc dissolved	61,940 = 60.6%
Gold in precipitate	2,380 = 0.39% effi'ncy
Silver in precipitate	16,000 = 4.75% effi'ncy
Copper in precipitate	7,800 = 3.93% effi'ncy
Total efficiency (Au, Ag, Cu).....	9.07% effi'ncy

"Percentage efficiency is calculated by dividing the weight in pounds by the electrochemical equivalent (Zn 32.7, Au 197.2, Ag 107.88, Cu 63.5, and Pb 103.6, under these conditions) dividing the quotient by the number of equivalents of zinc used, and multiplying by 100. The metallic zinc in dust has been taken throughout at the approximate figure of 90 per cent.

"Another instance may be taken from the published results of a month's run (May, 1911) of Sand Plant No. 1 of the Homestake Mining Co., in which the silver is about 1 per cent of the gold value. Some lead was added to the solution as nitrate and recovered in the precipitate.

"The efficiency for gold was 1.18 per cent, for silver, 0.73 per cent, and for copper 0.19 per cent, in the 'weak solution,' making a total efficiency of 2.1 per cent. Similarly the efficiency (Au, Ag, Cu) in the 'low solution' was only 0.71 per cent. At the same time about 1 per cent of the zinc was consumed in precipitating lead."

That such low efficiencies are tolerated in gold extraction is explained by the fact that when "low solution" is going to be thrown away it is obviously worth while to extract the last 2c. worth of gold recoverable, if this can be done at the expense of 1c. for zinc, making a fair allowance for refining cost. With zinc at 14.5c. per pound, 1 oz. Troy costs 1c. If this ounce is used to precipitate 0.001 oz. of gold (2c.) from a ton of waste solution the practice is defensible.

Salt in the Metallurgy of Lead.—A contribution on this subject from the Salt Lake station of the Bureau of Mines is published in the August *Bulletin* of the A. I. M. E. by Messrs. O. C. RALSTON, C. E. WILLIAMS, M. J. UDY and G. J. HOLT. The use of salt as a metallurgical reagent was suggested by the existence of Great Salt Lake and by the past work in chloridizing ores with salt. The experimental work covers a period of three years, during which the following classes of ores were studied: Oxidized ores containing lead, or lead and silver or gold, or lead and zinc with or without silver; sulphide ores of pyrite containing some lead, or complex zinc-lead-iron sulphides, or complex sulphides containing also precious metals. The summary follows:

"1. For the treatment of oxidized ores of lead two methods are available. One involves the leaching of the lead with a saturated salt solution acidified with sulphuric acid, followed by either electrolytic precipitation of metallic lead, or lime precipitation of the basic lead hydroxide with the concomitant regeneration of the salt solution. The other method involves mixing salt with the ore and treatment in a blast roaster, or a reverberatory furnace, at a temperature of 800 deg. C., or more. At these temperatures lead-chloride fumes are formed which can be caught in a Cottrell precipitator, and later reduced to the metallic form by treatment with lime and carbon in either a melting pot or a small reverberatory furnace, with the formation of calcium-chloride slag which can be used as a substitute for sodium chloride in the volatilization step of the process, and means the recovery of from 50 to 75 per cent of the chlorine.

"2. For oxidized lead ores containing precious metals or copper, the leaching process can be used after a chloridizing roast at slightly over 600 deg. C. The volatization process can be used provided temperatures of over 900 deg. C., are used, the ore does not tend to form a slag, and the percentage of sulphur in the ore is low. The zinc in most ores is only slightly affected by this latter process.

"3. Lead can be recovered from practically any sulphide ore by the volatization method, but precious metals and copper cannot be extracted. Precious metals and copper are leached after a chloridizing roast, although the roast is more difficult of accomplishment than is the case with oxidized ores.

"4. The volatilization process promises the solution of the vexing oxidized siliceous lead ores problem so common in the Western arid regions and has the further advantage of requiring very little water for the process. The chloridizing roasting and leaching method promises close competition to treatment of low-grade sulphide ores containing precious metals by gravity and flotation concentration followed by smelting, because of the use of only a few simple operations, the production of finished metal, and of the higher total extractions usually possible. Neither of the salt processes seems to offer a fundamental solution of the 'complex sulphide' problem.

"5. Installations of the volatization method for oxidized ores and of the roasting and leaching method for one sulphide ore are contemplated. The exact data on the ores and processes in these plants will probably be available at some future date."

Petroleum Shales

The commercial possibilities of petroleum shales, particularly those in the Green River formation of northwestern Colorado, are discussed in the *Oil and Gas News* by FREDERICK G. WIRTHMAN. Compared with Scottish shales, which yield a maximum of about 18 per cent oil and 2 per cent ammonium sulphate, the Colorado shales will yield up to 42 per cent oil and 6 per cent ammonium sulphate. According to estimates by the U. S. Geological Survey, the Colorado shales can be made to yield 20,000,000,000 barrels of oil. From the author's experience he would expect a commercial plant to yield the following for each ton of shale treated: 2 lb. of benzole, ½ lb. of cresol, ¼ lb. cresol, ¼ lb. phenol, 5 gal. gasoline, 25 gal. of burning oil, 10 lb. of wax and 100 lb. of ammonium sulphate.

Recent Metallurgical and Chemical Patents

Iron and Steel

Carbohydrates as Deoxidizing Agents.—The deoxidation of iron and steel baths by the addition of carbohydrates is patented by Adolf Klinkenberg, of Dortmund, Germany. Claim is made for complete deoxidation, with only traces of carbon entering the bath, and a special advantage is found in the production of very soft iron. The purer the carbohydrate the better the results obtained. Sugar, starch and cellulose are used with best effect, though wood and herbaceous plants such as leather have been used with success. When sugar or starch are used, 2.5 kg. are sufficient to completely deoxidize 1000 kg. of steel. With wood shavings 4 to 5 kg. are necessary. The addition is made preferably by introducing packages of the deoxidizer into the ingot mold when the molten metal is poured therein. Desulphurization also is accomplished, reducing the sulphur content of the metal to 0.02 per cent. (1,238,409, Aug. 28, 1917.)

Gold and Silver

Electrolysis of Cyanide Solutions.—Further investigation in the recovery of gold from cyanide solutions by electrolysis is indicated in a patent granted to U. C. Tainton and M. F. L. A. Aymard, of Johannesburg, Transvaal, South Africa. The invention comprehends passing solution under pressure through porous electrodes arranged in an apparatus similar to a filter press, anodes and cathodes alternating with distance frames. The object is to bring the solution into intimate contact with the material of the electrodes, thereby overcoming a defect in former processes. The inventors claim to be able to precipitate 99 per cent of the gold contained in a solution of 3 dwt. per ton in a single passage of the solution through the electrode in a period of less than 5 seconds. Electrodes are in the form of filter frames, the anode being composed of sheets of peroxidized lead covered with filter cloth, and the cathode of filter cloth supported on each side by wire gauze or perforated metal plate. In operation this cathode is to be covered with comminuted conducting material, such as finely divided graphite, which is deposited out of a liquid carrying the same in suspension. When the apparatus is thus prepared for use, a gold-bearing solution is passed through it, and gold is deposited on the graphite of the cathode. (1,231,967, July 3, 1917.)

Copper and Zinc

Electrolytic Precipitation of Copper.—The use of a semi-soluble (iron or steel) anode in the electrolysis of copper solutions is patented by George C. Westby, of Ludwig, Nevada. The object of the invention is to improve processes using insoluble anodes, and thereby overcome objections to such processes by increasing the current and energy efficiency of the operation. It has been established that if the copper solution carries 6 per cent of iron as ferrous sulphate at 60 deg. Fahr. rapid corrosion of the iron anode is prevented. In practice also, a film of carbon and silicious matter remains on the iron anode and further interferes with rapid decomposition. The inventor prepares his solution of copper by bringing roasted or oxidized ores into contact with hot sulphurous fumes containing both sulphur dioxide and trioxide from the decomposition of sulphides and sulphates in a roasting furnace. This solution, charged with SO_2 showing an equivalent acidity of about 1.5 per cent to 2 per cent sulphuric acid, and containing ferrous material, is caused to flow through a flume in which electrodes are placed paralleling the flume. The application of the electric current deposits copper and decomposes a portion of the anode, thereby adding to the ferrous material in solution, and exerting a strong reducing action on such ferric sulphate as might form. Either or both electrodes may be rotated in order that higher current density can be employed and in order to assist in the removal of polarizing gases. (1,231,829, July 3, 1917.)

Purification of Electrolyte.—In a patent granted to Frederick J. Pope and Albert W. Hahn, of Douglas, Ariz., the inventors disclose their proposed method of keeping the iron and other impurities in the electrolyte at a point consistent with economy in the electrolytic process of depositing copper from its solutions. A portion of the solution coming from the ore is withdrawn from the circuit, the amount depending on the quantity of iron to be removed. Free acid in this solution is neutralized by treating it cold with residues from a previous agitating operation, such residues still containing some copper oxide or sulphate. The neutral solution is then suitably heated and treated with finely ground material containing copper oxide in sufficient quantity to precipitate the iron, and agitation is continued for from two to five hours. Solution and residues are then separated, and the latter used for neutralizing a fresh batch of solution removed from the circuit. The solution thus freed from impurities and enriched in copper is sent to a separate series of cells where copper is recovered and sulphuric acid regenerated. (1,232,080, July 3, 1917.)

Leaching With Chloride Solution.—A hydrometallurgical process for copper, particularly applicable to ores contain calcium carbonate, is patented by Walter A. Schmidt, of Los Angeles, Cal., and by him assigned to the Western Precipitation Company. An active leaching solution is prepared by electrolyzing salt and conducting the chlorine into a leaching solution from which copper has been precipitated. This leaching solution consists of calcium chloride in water, say 5 per cent to 10 per cent strength, and from 0.1 per cent to 0.5 per cent iron as ferrous chloride. The latter is converted into ferric chloride by the chlorine, and again reduced to ferrous chloride when copper is dissolved from its ores. There is sufficient sodium chloride in the solution to carry the cuprous chloride dissolved. When the pregnant solution is precipitated on iron, ferrous chloride again enters solution and is regenerated to the ferric condition by chlorine. Any oxide or hydroxide of iron which is formed in the process is also dissolved to chloride, with the production of hypochlorus acid which is a good solvent for copper. (1,237,220-1, Aug. 14, 1917.)

Electrolytic Deposition of Zinc.—Apparatus for the production of electrolytic zinc in satisfactory physical condition is patented by Marcel Perreur-Lloyd, of of Boulogne-sur-Seine, France. It comprises a vessel in which are disposed rotating cathodes in the form of long cylinders, and anodes in the form of perforated lead troughs which almost completely surround the

cathodes, being open at the top. The open space at the top of the anodes permits the removal of cathodes when metal has been deposited to sufficient thickness, and also permits of the application of apparatus designed to remove hydrogen bubbles from the surface of the cathode and render the surface of the metal smooth and even. This latter device consists of fingers mounted on a reciprocating rod above the cathode, each finger carrying a pad of parchmented skin made insoluble by treatment in aldehyde or acetone. (1,235,723-4, Aug. 7, 1917.)

Zinc Retort Furnaces.—Inventions designed to improve retort furnaces for the reduction of zinc oxide to zinc are patented by EDWARD FINK, of Milwaukee, Wis. Figs. 1 and 2 indicate respectively vertical and horizontal sectional views of the apparatus. It comprises a furnace structure 1 and combustion chamber

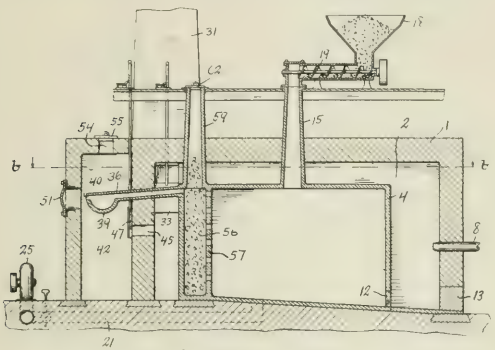


FIG. 1—RETORT FURNACE

2, enclosing retorts, 3, 4, 5 and 6. These latter are long, high and narrow, say 16 ft. long, 8 ft. high and 8 in. wide. They are charged through feed pipes 14 to 17, to which are connected hoppers and conveying mechanisms as shown. Doors 12 and 13 provide means for removing the smelted charge. In front of each retort is a reduction chamber 59, filled with coke to act as a screen to prevent fine dust entering the condenser 36, and to reduce any zinc oxide which may be volatilized before being reduced with the coal or coke that forms a part of the charge.

In another type of furnace the retorts are cylindrical and are vertically disposed in the furnace chamber.

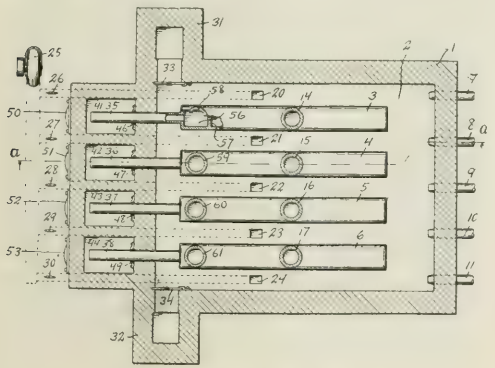


FIG. 2—RETORT FURNACE

Means are provided for charging at the top and removing the spent material at the bottom of each retort. (1,213,346-7, Jan. 23, 1917.)

Condensation of Zinc from Electric Furnace.—A method of handling the zinc dust, or *poussière*, produced in condensing zinc vapors, is patented by EDWARD S. BERGLUND, of Trollhättan, Sweden. In zinc condensation a part of the metal is not recovered as liquid but as powder due to the dilution of the vapors and the difficulty of maintaining in certain parts of the condenser the particular temperature necessary for the condensation of differently diluted zinc vapors. The inventor, therefore, constructs a furnace with two condensers, in the first of which the temperature is adjusted in such a manner that mainly liquid zinc will be condensed. The second condenser receives the gases from the first, cooling them to such an extent that practically all zinc contained therein is condensed as powder. In this way the liquid and powder zinc are separated. In order to prevent the exposure of the zinc powder to the air, where it would be quickly oxidized, the second condenser is provided with a screw conveyor operating in such a manner that the condensed powder is returned to the furnace for further distillation. (1,236,395, Aug. 14, 1917.)

Other Metals

Aluminous Abrasive.—An abrasive for which superior hardness, density, and toughness is claimed is patented by HERBERT T. KALMUS, and assigned to the Exolon Company, of Cambridge, Mass. The invention resides in provision for cooling the fused charge of an electric furnace, so as to permit loss of heat at such a rate as to produce a material that is hard, tough, fine-grained and dense. The preferred method of carrying out the process consists in fusing basic aluminium sulphite in an arc-type electric furnace, and in tapping off the fused alumina in a thin stream into a mold where it can cool rapidly. The fused material can be poured in successive layers in the same mold after each layer has solidified. The product is homogeneous and substantially free from reduction products. (1,226,892, May 22, 1917.)

Recovery of Aluminium and Silicon from Clay.—A metallurgical process and apparatus for this purpose are described in a patent issued to VICTOR M. WEAVER, of Harrisburg, Pa. The clay is treated with chlorine gas at a temperature between 900 deg. and 1200 deg. C., with the resulting formation of aluminium chloride and silicon tetrachloride. These products are condensed at appropriate temperatures, and the liquid aluminium chloride is kept at a temperature of about 200 deg. C. and under a pressure of about 2½ atmospheres. It is subsequently fed to an electrolyzing vat containing fused sodium chloride, and the consequent electrolysis produces metallic aluminium and chlorine. The silicon tetrachloride is fed into a vat containing molten aluminium, where by reason of the greater affinity of chlorine for aluminium than for silicon, the latter is reduced with the formation of aluminium chloride. This is then reduced in the electrolyzing vat as first described. (1,238,604, Aug. 28, 1917.)

Production of Titanic Oxide.—A method of obtaining the oxide of titanium, essentially pure, from such

substances as titaniferous iron ore, ilmenite, rutile, etc., is disclosed in letters patent granted to Louis E. Barton, of Niagara Falls, N. Y., and by him assigned to the Titanium Alloy Manufacturing Company of Niagara Falls. The process consists in dissolving the titaniferous material in sulphuric acid and using this solution as the catholyte in a diaphragm cell, the anolyte of which is sulphuric acid. Lead electrodes are employed. The voltage used is from 5 to 10 volts and the current density about 30 amp. per square foot. The result of the electrolysis is the production of a hydrated compound of titanium which, when calcined at 750 deg. C., is converted into substantially pure titanium oxide. (1,235,638, Aug. 7, 1917.)

Recent Developments in Blast Furnace Blowing Equipment

By E. M. Griffiths

After the general adoption of the steam turbine in large central power stations, the erroneous impression gained ground that the replacing of the reciprocating blowing engine by the turbo blower could only be a question of a comparatively short time. This expectation of the uninitiated was not realized and it is doubtful if it will ever be realized.

The same laws of nature which give the steam turbine advantages over the steam engine are obstacles in the case of the turbo blower. Firstly, the steam turbine excels the steam engine only in the region below atmosphere, and in the compression of air for blast-furnace use this region is absent because, naturally, the compression must start with atmospheric pressure. Secondly, the losses in the earlier or high pressure stages of steam turbine are converted into heat which can be utilized in the latter stages, while in the turbo blower the losses in the early or low pressure stages mean additional work to be done in the latter stages. Thirdly, the steam turbine utilizes the highly efficient process of converting pressure into velocity, whereas, the turbo blower tries to utilize the very inefficient process of converting velocity into pressure. Fourthly, the central power station utilizing large turbo generators makes power for the sake of selling it. High steam pressure, superheat and vacua, which are impracticable around a blast furnace, can be introduced in the central station. Larger and larger units can also be installed, whereas the size of the turbo blower is limited by the size of the blast furnace.

While for these very reasons engineers with knowledge of the underlying principles always had their doubts concerning general adoption of the turbo blower, another rather unexpected reason has considerably delayed and hindered its introduction. The reason in question is incorrect governing of the blower and consequent dusting of the furnace. The turbo blower is a machine supposedly free from pulsations, and great advantages were expected from a steady stream of air going to the furnace. But practice has shown that, quite on the contrary, the vast majority of turbo blowers vary in volume delivery a much greater amount than reciprocating blowing engines do. The amount of ore lost by dusting due to this fluctuation of air supply is so great that most blast furnace managers are, at the present time, afraid to install turbo blowers.

In blowing engines the course of development likewise has been following rather unexpected lines. By comparison of the number of new furnaces built with the number of new blowing engines and new turbo blowers installed, it is found that a comparatively small amount of new blowing equipment has been added. This surprising result is explained by the fact that a very large number of existing blowing engines have been rebuilt in such a way as to have a larger capacity and to serve a greater number of furnaces than heretofore. The possibility of increasing the capacity of existing blowing engines is largely due to the increase in piston speeds made possible by the introduction of plate valves, which have been mentioned before in our columns.

The so-called rebuilding of blowing engines is, in some cases, limited to the simple replacing of the existing valves by automatic plate valves. In other instances it means more than that, namely, the removing of old cylinder heads and replacing them by heads containing plate valves. In the most extreme cases it means the removal of the whole air end, including the air cylinder.

An illustration of the methods employed in replacing an old type of valves by plate valves is shown below in Fig. 1. Here are seen plate valves arranged in cages, which take the place of large poppet valves

FIG. 1—PLATE VALVES ARRANGED IN CAGES

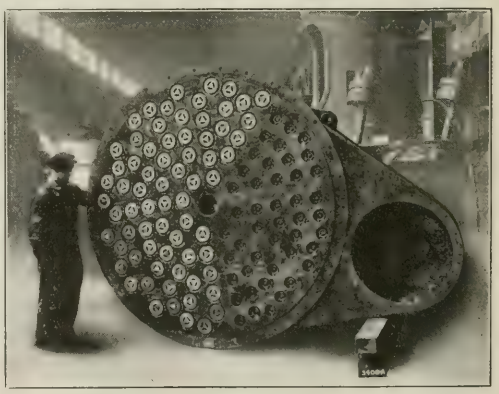


FIG. 2—METHOD OF INSTALLING VALVES IN HEAD

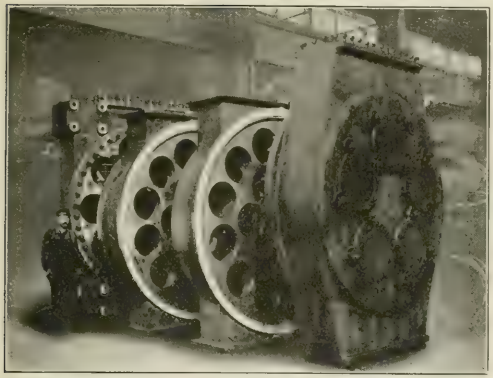


FIG. 3—REPLACING OLD AIR HEADS WITH NEW ONES

originally operating in the head. The cages are dished in order to reduce clearance to a very small amount. In many cases the clearance volume is smaller than it was with the original valves, while in other cases it is increased slightly, depending upon the type of valves being replaced by the cages. But even in this latter case the advantages gained by the instantaneous opening of the valves and the larger area secured are so overwhelming that the slight increase in clearance volume fades into insignificance.

The arrangement of the valves in cages offers several advantages. The removal of one cover plate exposes all outlet valves of the cage to inspection on the delivery side. The inlet cages are made in two parts so that the removal of one cover and the top of a cage exposes all the valves of that cage to inspection. In the extremely rare case of breakage of a valve, the whole cage can be easily removed and replaced by a spare one.

Fig. 2 illustrates the method of installing valves in place of existing valves in the head. This latter method as a rule gives some increase in valve area, but not enough to warrant increasing the speed of the engine materially. This method is to be recommended particularly in the case of old blowing engines equipped with leather valves. The advantage is twofold: first, the plate valves are always tight and in consequence deliver more air, whereas leather valves soon begin to leak, due to warping or charring of the leather; second, higher pressure can be blown.

The second method, namely, that of replacing old air heads with new ones, is very widely practiced at the present time. Fig. 3 (2133) shows the appearance of such air heads. The third and last method, namely, that of replacing the old air end has been necessary only very occasionally.

Mention has already been made of the fact that plate valves allow higher piston speeds. This feature is beneficial in several ways. At present, due to the poor grade of coke available, many furnaces are troubled by the necessity of more air than was used in the past when better coke was on hand. Increasing the supply of air has pulled several furnaces out of a bad predicament. More air means not only more pig iron, but in addition more furnace gas, more steam, and steady, profitable operation.

The installation of plate valves and the resulting possible increase in speed of the blowing engines has enabled a number of plants to erect another furnace without installing additional blowing units. The heretofore customary practice of blowing a furnace with three or sometimes four tubs has given way to the present possibility of blowing a furnace with two tubs only; and, in fact, a great many furnaces in this country are being blown to-day, using only two 84-in. diameter blowing tubs equipped with automatic plate valves. From this it can be seen that the blowing capacity of existing plants can be increased 50 to 100 per cent by equipping the present engines with automatic plate valves.

Mesta Machine Co.,
Pittsburgh, Pa.

Chemical Industries of Austria-Hungary

The chemical industry in Austria-Hungary has remained in a somewhat backward condition, at all events as compared with that of Germany, owing to various causes, such as lack of navigable rivers and canals, high railway rates with consequent high prices for coal and other raw material, antiquated company laws, absence of an enterprising and industrial spirit, and a comparatively limited domestic market. In the economic life of the country the chemical industry plays only an insignificant part, and the number of chemical undertakings was small, and these, indeed, were only of moderate size compared with those in Germany. On the outbreak of war this state of things was keenly realized. The absence of certain raw materials, saltpetre, for instance, necessitated the search for a substitute. The very limited number of chemical works involved the extension of existing ones and the erection of new factories. The manufacture of nitric acid and nitrate of lime from the air was established on a scale undreamed of in peace times; the production of sulphuric acid was enormously increased; factories were also erected for the manufacture of benzole, toluol, glycerine, acetone and for the production of sulphur, chlorine, etc. The mineral wealth of the country was exploited to a much greater extent than before; the sulphuric-acid industry was rendered largely independent of foreign pyrites, and lead and copper and other metals were obtained. The Galician petroleum wells supplied the whole of the Central Powers with oil for light, power and lubrication.

The Austrian chemical industry has, therefore, according to the *Chemical Trades Journal & Chemical Engineer* (information from *Neue Freie Presse*), undergone a tremendous revival and expansion, and it will endeavor to maintain its position after the war. The home industry, it is said, will supply the home demand for chemicals to a much greater extent than heretofore, at first with tariff protection if necessary. The war has shown the supreme importance of the chemical industry to the safety of the State; and its importance to the country's welfare in normal peace times is equally clear and indisputable.

Book Review

Chemical Patents and Allied Patent Problems, by Edward Thomas (John Byrne & Co., Washington, D. C.)

This book presents in very compact form a clear statement of the intention of the patent law of the United States in combination with a reference digest of some

1300 chemical or allied cases illustrative of the interpretation of the law as indicated by judicial opinion.

The digest is in the form of 245 foot notes, to which reference numbers are given in the text. Thus the statements of the text, as one proceeds, are sustained by, or built upon, the citations given in the foot notes. The subject of the text is rendered easily accessible by an extremely comprehensive index having 116 headings, with reference to the pages of the text. Of the 38 pages of the text more than two-thirds of the space is occupied by the 245 foot notes, which are in slightly smaller type than the text.

A complete table of cases gives its references to the serial numbers of the "Notes," which follow consecutively in the text. If, therefore, one wishes to know what is the intention of the patent law, in any particular case, he has but to refer to that portion of the text having the numbers corresponding to those appearing opposite the name of the case given in the alphabetical table of cases. A "Table of Parallel Volumes," from the year 1872 to 1916 inclusive, enables one to locate citations in all of the different authorities.

The book is written from the point of view of an attorney or expert witness instead of that of a Patent Office Examiner, and with that point of view in mind, has specific notes upon the kind of evidence needed, together with notes covering the cases on damages, licenses, etc.

The chemical engineer, and, though less frequently, also the metallurgist, finds it necessary to ascertain the underlying principles of patent law and to familiarize himself with the cases upon which the law of chemical patents is based. For such a purpose this book would render invaluable assistance, and even as a matter of general interest it is fascinating. As a "finding list" for the attorney it would appear indispensable as a time saver.

Personal

Mr. **H. W. Aldrich** has been appointed general superintendent for the Ladysmith Smelting Corporation (British Columbia). Mr. Aldrich had been in the Washoe Plant of the Anaconda Copper Mining Company for ten years, during which time he worked up through the testing department and laboratory to the position of assistant chief chemist. He was in charge of the experimental plants which developed their leaching process, of the completed 2000-ton Leaching Plant, and was later superintendent of the Blast Furnace Department.

Mr. **H. J. Broderson,** instructor in industrial chemistry at the University of Illinois, has accepted a position with the Standard Oil Company at Whiting.

Mr. **Sidney Cadwell** has joined the staff of the Federal Dyestuff and Chemical Co., Kingsport, Tenn. He received his Ph.D. at the University of Chicago during the summer.

Mr. **John Gross** has been appointed metallurgist with the U. S. Bureau of Mines and will be stationed at Fairbanks, Alaska.

Mr. **H. E. Hollister** has resigned as chief engineer of both the Kalbperry Corporation and the Kalbfleisch Corporation to devote his time to the promotion of his newly patented process for the conversion of nitre cake into sulphuric acid and salt cake.

Mr. **E. Jordan** of Toronto, Ont., has been appointed general manager and chief engineer of L'Air Liquid Societé, of Maisonneuve, Que., in succession to E. Royer, who resigned to go into business in Montreal. Mr. Jordan recently came to Canada from France, where the parent company is located. The company is erecting a new manufacturing plant at Halifax, N. S., and is building an addition to its Toronto plant.

Mr. **J. C. Lathrop** has been appointed manager of the recently opened Cincinnati office of the Asbestos Protected Metal Company of Pittsburgh, Pa.

Mr. **W. D. Leonard,** formerly superintendent of the Garfield Smelting Co., has been appointed assistant to the general manager for Colorado of the American Smelting & Refining Co., with headquarters in Denver.

Dr. **Ralph H. McKee,** head of the Research Department of the Tennessee Copper Company, has been appointed to an Associateship in the Department of Chemical Engineering, Columbia University. He will have charge of the work in industrial organic chemistry given by that department. This is the work previously given by Drs. Teeple and Whitaker.

Mr. **Henry A. Oesterle** has been advanced to the post of resident agent for the Illinois Zinc Co. at Joplin, Mo., succeeding the late John Immel. Mr. Oesterle was formerly at the company's headquarters in Peru, Ill.

Mr. **Alfred H. Ramage,** manager of the Ramage mines in Missouri and Oklahoma, has reported for service at the officers' training camp at Fort Niagara, N. Y. He is succeeded in the general management of the Ramage interests by Mr. J. H. Capelli, formerly superintendent of Ramage No. 4 at Carterville, Mo.

Mr. **E. N. C. Rogers** of the Procter & Gamble Co. has taken the September examination of the Cincinnati Board of Education for a special Teacher's Certificate in "English for Foreigners." This is in continuation of the line of "Safety First" campaigning and the teaching of Industrial Arts to which Mr. Rogers devotes his spare time.

Mr. **J. E. Schott** has accepted a position as chemist in the research laboratory of the Federal Dyestuff and Chemical Company, Kingsport, Tenn.

Mr. **A. D. Shankland** has been appointed chief chemist of the Lehigh and Saucon plants of the Bethlehem Steel Co., succeeding F. O. Kichline, recently transferred to Lebanon, Pa. Samuel Lewis has been appointed chemist at the Saucon laboratory, succeeding A. R. Hartzell, resigned.

Dr. **T. Dale Stewart** of the University of Chicago has gone to Berkeley, Cal., where he has a position as instructor in chemistry at the University of California. He has been in Pittsburgh for several weeks where he has been doing research work for the government.

Mr. **Francis A. Thomson** has resigned as dean of the School of Mines, Pullman, Wash., and will accept a similar position in the University of Idaho.

Mr. **H. N. Thomson** has resigned his position as metallurgist for the United Verde Copper Co. and has entered consulting practice. His address is 918 S. Kingsley Drive, Los Angeles, Cal.

Mr. **Norman L. Warford,** mechanical engineer, in charge of construction for the Powdered Coal En-

gineering & Equipment Company of Chicago, sailed from New York on August 31 to take up his new duties as engineer in charge of the coal pulverizing and copper smelting department of the Societe des Mines de Cuivre de Catemou at Catemou, Chile. Mr. Warford has had many years experience in the use of powdered fuel and was the designer and first operating superintendent of the installation of the Anaconda Copper Mining Company, at Anaconda, Montana, where about one thousand tons of powdered coal per day are used in reverberatory copper smelting furnaces. Mr. Warford was with the Anaconda Copper Mining Company from December 1, 1913, until November 1, 1916, when he went to the Powdered Coal Engineering & Equipment Company. He has been using powdered coal since 1897, principally in cement manufacture, and has had a like experience in designing, erecting and operating cement plants and powdered coal installations for cement, copper smelting and steam raising.

CURRENT MARKET REPORTS

The Iron and Steel Market

The iron and steel market has continued generally stagnant, the monotony being broken occasionally by price declines, relatively minor in their character considering the extent of the readjustment that will probably have to occur before a really active market again presents itself.

In the case of finished steel products the slight declines that have occurred thus far have, in essence, been a reduction in premiums involved on early deliveries, for as a rule the latest advances in the upward movement occurred on early deliveries, buying for really forward delivery having been practically suspended, not later than last April. In the case of pig iron the relatively slight declines that have occurred have been from a completely established market, for the highest prices developed on the rise were being paid for late deliveries, chiefly the fore part of 1918, as consumers were almost entirely covered for the remainder of this year before the last advances occurred.

Basic pig iron, which attained a level of $54, valley, late in June, sold in the past fortnight at $42, with more iron offered at the price than was absorbed. In other grades of valley iron, and in other markets, there was no corresponding pressure of offerings and price declines have been slight. It is obvious that appraised values have decreased but there has been so little trading that the full decrease has not been written into the actual quotable market. The furnaces endeavor to maintain quotations and transactions are confined to small lots for immediate shipment, the price being of minor consequence to the buyer.

The whole market situation, in pig iron, unfinished steel and finished steel, is that buying is confined to pressing requirements and involves very small tonnages. The transactions are not such as to develop real values, as the quantities bought are inconsequential to the buyer and the price paid is unimportant.

THE GOVERNMENT AND PRICES

When this market stagnation developed, late in June and early in July, there was a disposition to maintain that the trade was waiting upon action at Washington in the matter of price fixing, and it became a common saying that the market was "waiting upon action at Washington." If such a view were ever correct, it certainly has not been correct in the past few weeks. It is obvious that there is no conceivable action Washington could take that would bring buyers of iron and steel into the market so as to inaugurate a fresh buying movement.

The Government can fix prices upon the steel it buys, but it seems to be settled now that there will be no general price schedule, fixing flat prices that shall be paid upon all purchases. Rather the practice is to place orders at definite prices, but which are considered tentative while operating costs during the filling of the orders are studied. The Government is indisposed to announce the prices it pays, and as producers feel that the open market would tend to decline to the Government level in case the prices became public they are indisposed to give out the information. Thus this business does not tend to set a pace for the general market.

As to purchases by or for the account of our Allies, there is serious question whether the Government has power to fix prices, and even if it had, the prices would be no more likely to become established as matter of common knowledge than prices paid for the Government's own steel. Thus in this respect there is no action to be taken by Washington that would furnish a lead for the general market.

There remains the matter of the Government fixing prices for the general market, as was done August 21 in the case of coal. The authority is not vested in the executive at present, but this is contemplated in the Pomerene bill now in the Senate. If this bill should be passed and acted upon, both contingencies being quite doubtful, it is quite certain that the market would not immediately proceed to trade at the prescribed prices. The Government cannot force either sellers or buyers to act. Either sellers would refuse to sell, as long as they had any orders to fill, or buyers would refuse to buy as long as they had any material in stock or due them. The last ton of business now under engagement would have to be carried out before there would be any general action.

If the market is allowed to proceed to develop itself according to normal trade practices it would find its level, a level at which buying and selling on a fair scale could go on, at a much sooner date, hence action at Washington is completely eliminated as the chief market factor for the next definite turn in the iron and steel market.

BUSINESS ON BOOKS

The blast furnaces are sold up practically full to the end of the year, and as to 35 to 60 per cent of their prospective output in the first half of the new year. The large steel mills are claimed to be sold fully to the end of the year, with much business under engagement for the new year. The Steel Corporation's unfilled obligations are slightly in excess of 10,000,000 tons, equal to production for 200 working days, if suitably distributed in the different departments and certain to be specified against. At the middle of last year it was believed that fully one-half the mill obligations were in the form of actual shipping orders. At the present time the proportion is much less. The smaller mills

have much smaller obligations, relative to capacity, than the large mills.

The steel market is usually discussed from the viewpoint of the seller, but there are two sides. When the business tide is rising, the feature of the situation is that the mills have a given tonnage already sold. With prices advancing buyers are sure to call for all the tonnage by which the mills have obligated themselves. When the tide is ebbing, the tonnage on books must not be looked upon as so much sold, but rather as so much bought. If a tonnage has been sold it also has been bought, and if the tonnage bought is more than the buyers find they will require, and therefore more than they will specify, the magnitude of the tonnage involved is not an element of strength, but rather the reverse.

PROSPECTS OF CONSUMPTION

A sketch of the situation and prospects as to consumption is as follows. In 1912 and 1913, the two largest years before the war, the domestic consumption, indicated by the total rolled steel production minus all exports direct and indirect, was a trifle less than 21,000,000 gross tons. A similar computation for 1916 shows a trifle under 25,000,000 tons. The present capacity is about 35,000,000 tons, with production at the rate of between 90 and 95 per cent of capacity. Requirements for the future involve: (1) Steel required by the Government; (2) steel required by our Allies; (3) steel required by ordinary domestic consumers. The Government requirements, according to orders thus far placed or in prospect, do not seem to involve more than 10 to 15 per cent of the output. The requirements of the Allies have not been expressed, to any extent, for several months. Heavy shipments have been going forward without a corresponding amount of fresh buying. In order that the combined war requirements should amount to 30 per cent of the total capacity there will have to be much more buying for account of the Allies than has lately been the case. If eventually the buying should prove heavier than formerly it will be time enough then to consider the situation. At 30 per cent for the war requirements of the Government and its Allies, full production of steel would find an outlet only in case the ordinary domestic consumption were as great as in 1916, and this seems unlikely to be the case, when building operations are being suspended very largely and the mass of the people are practicing voluntary or forced economy. From this viewpoint the readjustment in iron and steel prices, which has been proceeding in very modest fashion in recent week, is liable to go to great lengths eventually.

Non-Ferrous Metal Market

Monday, Sept. 24.—The chief features have been the continued rise in silver and the decline in lead, which experienced two sharp breaks.

Copper.—The copper market continues dull with now and then a slight sign of activity. Rumors were still going the rounds in regard to Government price fixing. Prompt electrolytic is quoted at 26.50 to 26.75 with November 26.25 and December, 26.00. These are holder's prices. Prompt lake is held at 27.00 to 27.75.

Tin.—The tin market continues dull, the foreign market declining on Sept. 20 £1 in London to £244 on spot Straits. Spot Straits in New York is held at about 61.25 cents. Banca is 59.50, with Chinese No. 1 at 55.50 for futures. Straits for December-January shipment from the East Indies can be had for 56.50. Arrivals up to Sept. 21 were 1685 tons—a very low figure.

Lead.—The trust reduced the price twice since our last report, first to 9 cents on the 13th and then to 8 cents on the 18th. These cuts bring the price down to the level of the price fixed for lead by the Government. The price of 8.00 cents is also asked by independents and no reduction is quoted on deliveries up to November. The reductions have stimulated buying somewhat.

Spelter.—There is nothing new in the spelter market, except that the Government is buying on competitive bids instead of fixing a price and then allotting contracts. Prompt spelter is quoted at 8.25 E. St. Louis and 8.42½ New York.

OTHER METALS

Antimony, Chinese and Japanese, pound		$0.15¼
Aluminium, No. 1 Virgin, 98-99 per cent, pound	.41	.42
Magnesium, metallic, pound	2.00	2.50
Nickel, electrolytic, pound		.55
Cobalt, pound		2.70
Cadmium, pound		1.50
Quicksilver, flask		115.00
Silver, ounce		1.06½
Platinum, pure, ounce		105.00
Palladium, ounce		115.00

Chemical Market

COAL TAR PRODUCTS.—The general position of these markets has been rather quiet with some items a trifle easier for the fortnight.

Benzol.—Orders are still rather limited but prices are somewhat steadier under the influence of increased buying interest. A few contracts for picric acid have been let, taking some of the surplus stocks of benzol off the market.

Aniline Oil.—The market has not been particularly active and the export business has been limited. Prices are still comparatively low in comparison with the cost of production. The situation has not favored the manufacturer of late.

Paranitraniline.—Business has been quiet, causing a contraction of production. Prices have remained fairly steady. A few important inquiries, however, have been noted lately.

Metanitraniline.—Three of four domestic manufacturers have had very little to offer recently and prices are higher. A new production is offered on contract and the steady demand bids fair to absorb everything offered.

Monochlorbenzol.—Export inquiries have been light. Supplies have been adequate and prices have been about the same as before.

Dinitrochlorbenzol.—The absence of business has brought about lower prices and as competition grows the market weakens.

Toluol.—About 95 per cent of the present production is going into the manufacture of explosives. Dye manufacturers are experiencing difficulty in securing supplies. Prices on short term contracts are firm with an advancing tendency.

Dinitrotoluol.—The one or two new producers are having but little difficulty in selling their product and prices are firmly maintained.

Toluidines.—These products are about as previously noted. An active demand prevails for the para. Prices about unchanged.

Naphthalene.—The spot market is very quiet. Some price shading is in evidence. Large producers have just established their 1918 prices to the drug trade and these are about 2c. higher than this year's contract prices. The contract inquiry is widening.

Phenol.—The market is stronger and prices are on the advance. Considerable spot business of much importance has passed and contracts especially are wanted.

Dinitrophenol.—Prices on this intermediate are lower owing to competition. Several important inquiries, however, have developed of late.

Para-amidophenol.—The production is increasing and prices are somewhat lower on competition. The demand however is quite steady for both the base and the hydrochloride.

HEAVY CHEMICALS.—During the last couple of weeks considerable activity has been in evidence, and this was not alone true of a few speculative items, but was along general lines, and the indications are now that the coming season will be one in which a large volume of business will be regularly in evidence.

Caustic Soda.—Prices have almost steadily advanced although during the last few days a slight reaction has taken place; this, however is expected to be only temporary, as makers are well sold up for nearby delivery and on contract over next year. The speculative element has and is playing an important part, but the fact remains that consuming business has been exceedingly heavy; exports especially to France, Italy and the Orient have broadened a great deal lately. A great deal of interest is attached to next year's business, and there are very few makers who have not sold a large part of their production for this position.

Soda Ash.—Not a little activity has come to this market, and prices are somewhat higher, because of the fact that demand has been heavier induces many buyers to cover on forward positions, and practically all futures now are held at higher prices.

Bleaching Powder.—Nothing of importance has occurred, and sellers are still quoting rather low prices for nearby delivery in domestic drums; the export inquiries are fairly good, and business appears to be increasing somewhat.

Cyanides.—The markets have been fairly steady and the inquiry for the potassium is a bit stronger under light offerings. Demand also for the sodium has improved somewhat, and prices are a few cents higher than a fortnight ago.

Barium Compounds.—There has been considerable activity lately, especially in the carbonate, makers of which have in most cases sold ahead. The demand for the chloride and nitrate appears to be improving somewhat, and sellers are holding now with more firmness than heretofore.

Silicate of Soda.—Supplies of the 60-deg. material are exceedingly scarce, and sellers are not in a position to take any nearby business, and futures are higher in price; occasionally a lot reaches the open market but as a rule this goes immediately into consuming channels at rather high prices; the 40-deg. material is also firm, although not so difficult to obtain as the higher grade.

Bichromate of Soda.—Under heavy speculation, and the efforts of large manufacturers, the prices have advanced considerably, although during the last week or so demand has let up somewhat, and slight reactions were taken; in view of the fact, however, that 1918 contracts are to be placed within the next few months, an effort will be made to maintain values.

Bichromate of Potash.—There is a fairly strong tone to the market, and sellers are holding with a great deal of firmness at the recently increased levels.

Chlorates.—There is a fairly strong tone to the market for both the potash and soda, and prices have been maintained with a great deal of strength.

Copper Sulphate.—Nothing of unusual interest has developed, and sellers continue to quote at prices that have been evidence for some time. There is a steady tone to the market, and export business is fairly active.

Arsenic-White.—There is a good demand for this product, and sellers in some cases have advanced their prices for nearby delivery.

Arsenate of Lead.—Large makers have just announced their prices for nearby delivery and on contract, and the insecticide trade is coming into the market in fairly good volume.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET SEPT 20, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.35 —	.36
Acid, acetic, 28 per cent	lb.	.06 —	.06½
Acetic, 56 per cent	lb.	.11 —	.13
Acetic, glacial, 99½ per cent, carboys	lb.	.37 —	.38
Boric, crystals	lb.	13½ —	.14
Citric, crystals	lb.	.72 —	.72½
Hydrochloric, commercial, 18 deg.	lb.	.01⅝ —	.01¾
Hydrochloric, 20 deg.	lb.	.01¾ —	.01⅞
Hydrochloric, C.P., conc., 22 deg.	lb.	.01⅞ —	.02
Hydrofluoric, 30 per cent, in barrels	lb.	.05 —	.05¼
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.05 —	.05½
Nitric, 36 deg.	lb.	.07¼ —	.07⅝
Nitric, 42 deg.	lb.	.07⅞ —	.08
Oxalic, crystals	lb.	.46 —	.47
Phosphoric, 85 per cent	lb.	.35 —	.39
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3.20 —	3.30
Sulphuric, 60 deg.	ton	27.00 —	30.00
Sulphuric, 66 deg.	ton	34.00 —	35.00
Sulphuric, oleum (Fuming), tank cars	ton	40.00 —	45.00
Tannic, U. S. P., bulk	lb.	1.35 —	1.40
Tartaric, crystals	lb.	.78½ —	.79
Alcohol, grain, 188 proof	gal.	4.30 —	4.35
Alcohol, wood, 95 per cent	gal.	1.10 —	1.12
Alcohol, denatured, 180 proof	gal.	1.00 —	1.02
Alum, ammonia lump	lb.	.04¼ —	.04½
Alum, chrome ammonium	lb.	.18½ —	.19
Alum, chrome potassium	lb.	.25 —	.27
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08½ —	.09
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03¼ —	.03½
Ammonia aqua, 26 deg. carboys	lb.	.12 —	.13
Ammonium carbonate	lb.	.11¼ —	.12
Ammonium nitrate	lb.	.22 —	.24
Ammonium, sulphate domestic	lb.	.07¼ —	.07¼
Amyl acetate	gal.	4.50 —	4.60
Arsenic, white	lb.	.16 —	.16½
Arsenic, red	lb.	.60 —	.65
Barium carbonate, 99 per cent	ton	70.00 —	75.00
Barium carbonate 97-98 per cent	ton	65.00 —	
Barium chloride	ton	85.00 —	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.11½ —	.12
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¾ —	.02¼
Borax, crystals, sacks	lb.	.08 —	.08½
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.70 —	.80
Calcium, acetate, crude	lb.	.03 —	.03½
Calcium, carbide	lb.	.08½ —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.		
Carbon bisulphide	lb.	.17 —	.17½
Carbon tetrachloride, drums	lb.	.16½ —	.16¾
Caustic potash, 88-92 per cent	lb.	.85 —	.87
Caustic soda, 76 per cent	lb.	.09⅝ —	.10
Chlorine, liquid	lb.	.15 —	.40
Cobalt oxide	lb.	1.40 —	1.50
Copperas	100 lb.	1.00 —	1.05
Copper carbonate	lb.	.45 —	.47
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09¼ —	.09½
Cream of tartar, crystals	lb.	.50 —	.51
Epsom salt, bags	100 lb.	4.15 —	4.25
Formaldehyde, 40 per cent	lb.	.16 —	.16½
Glauber's salt	100 lb.	.80 —	.85
Glycerine, bulk, C. P.	lb.	.65 —	.66
Iodine, resublimed	lb.	3.50 —	3.55
Iron oxide	lb.	.14 —	.15

Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.13½	—	.14
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.12½	—	.12¾
Lithium carbonate	lb.	1.02	—	1.05
Manganese dioxide, U. S. P	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.16	—	.16½
Nickel salt, single	lb.	.11	—	.11½
Nickel salt, double	lb.	.08	—	.08½
Phosphorus, red	lb.	1.50	—	1.60
Phosphorus, yellow	lb.	2.20	—	2.25
Potassium bichromate	lb.	.44	—	.45
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.30	—	2.50
Potassium iodide	lb.	2.00	—	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330.00	—	340.00
Potassium nitrate	lb.	.29	—	.30
Potassium permanganate	lb.	4.00	—	4.25
Potassium prussiate, red	lb.	2.90	—	3.00
Potassium prussiate, yellow	lb.	1.20	—	1.25
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray grain	lb.	.11	—	.11½
Salammoniac, white gran	lb.	.16	—	.16½
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide, based on market price of silver	oz.			
Silver nitrate	oz.	.64	—	.66
Soda ash, 58 per cent. light, flat	100 lb.	3.50	—	3.60
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.11	—	.11½
Sodium benzoate	lb.	1.75	—	2.00
Sodium bicarbonate, domestic	100 lb.	2.45	—	2.50
Sodium bicarbonate, English	lb.			
Sodium bichromate	lb.	.26	—	.27
Sodium bisulphite, powd	lb.	.04½	—	.05
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	5.00	—	5.25
Sodium nitrite	lb.	.45	—	.50
Sodium peroxide	lb.	.75	—	.80
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.36½	—	.37
Sodium silicate, liquid 40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3.10
Sodium sulphide, 60 per cent, fused	100 lb.	4.50	—	4.55
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.16	—	.17
Zinc cyanide	lb.	.50	—	
Zinc dust 350 mesh	lb.	.17	—	.19
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.06	—	.06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	—	.52
Benzol, 90 per cent	gal	.50	—	.52
Toluol, pure water white	gal	1.75	—	1.80
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthylamin	lb.	.70	—	.75
Aniline oil	lb.	.26½	—	.27
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.85	—	1.90
Benzidine, sulphate	lb.	1.50	—	1.55
Benzoic acid	lb.	1.75	—	2.00
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.50	—	9.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	
Dichlor benzol	lb.	.12	—	.18
Dinitrochlorbenzol	lb.	.42	—	.44
Dimethylaniline	lb.	.57	—	.59
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09	—	.09¼
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.			
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P	lb.	.42	—	.43
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.50	—	15.00
Salicylic acid	lb.	1.40	—	1.50
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	
Corning, Ohio	bbl.	2.60	—	
Somerset, Ky	bbl.	2.40	—	
Wooster, Ohio	bbl.	2.38	—	
Indiana	bbl.	1.98	—	
Illinois	bbl.	2.12	—	
Oklahoma and Kansas	bbl.	2.00	—	
Caddo, La., light	bbl.	2.00	—	
Corsicana, Tex., light	bbl.	2.00	—	
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	

Fuel Oil

New York	gal.	.10½	—	
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	.70	—	1.55
Texas	bbl.	1.75	—	
Los Angeles	bbl.	1.45	—	
San Francisco	bbl.	1.45	—	

Gasoline (Wholesale)

New York	gal.	.24	—	
Boston	gal.	.25	—	
Pittsburgh	gal.	.25	—	
Chicago	gal.	.21	—	
Oklahoma	gal.	.23	—	
San Francisco	gal.	.20	—	

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal	.21	—	.26
Cylinder, dark	gal	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52		
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	
Wood creosote, ref	gal.	.30½	—	

Vegetable and Other Oils

China wood oil	lb.	.19½	—	.20
Cottonseed oil, crude	gal.	1.06	—	1.08
Linseed oil, raw, cars	gal.	1.20	—	
Peanut oil, crude	gal.	1.17	—	1.20
Rosin oil, first run	gal.	.35	—	
Rosin oil, fourth run	gal.	.66	—	
Soya bean oil, Manchuria	lb.	.14	—	.14½
Turpentine, spirits	gal.	.44	—	

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.65	—	.68
Carnauba wax, flor	lb.	.53	—	
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	
Rosin, 280 lb	bbl.	6.00		
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	18.00
White lead, dry	lb.	.11½	—	

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	
Ferrochromium, per lb. of Cr	lb.	.30	—	.40
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.00
Molybdenite, per lb. of MoS_2	lb.			2.20
Tungsten, Scheelite, per unit of WO_3	ton			25.00
Tungsten, Wolframite, per unit of WO_3	ton			24.00
Uranium oxide, 98%	lb.	3.40	—	3.60
Vanadium Pentoxide, 99%	lb.			11.00

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

Allied Drug & Chemical Corp., Wilmington, Del. Capital $1,000,000. To make drugs, chemicals, etc. W. S. Randall, F. A. Armstrong, C. M. Egner, Wilmington, Del.

The Alosta Chemical Co., Los Angeles, Cal. Capital $10,000. W. R. McNair, S. A. Wright and L. Hyde.

The Ambler Chemical Corp., Pearl River, N. Y. Capital, $100,000. To manufacture chemicals and allied products. Incorporators are A. R. Oakley, Pearl River; W. E. Shields, Jr., and Paul E. Britsch, Brooklyn, N. Y.

American International Steel Corp., Portland, Me. Capital $1,000,000.

The Argo Oil Company, Dover, Del. Capital, $10,000. To develop oil lands. Incorporators are G. G. Stiegler, William F. O'Keefe and E. E. Wright, Wilmington.

Atlantic & Pacific Safety Explosives Corp., Wilmington, Del. Capital $500,000. To make, sell and deal in all kinds of powder and explosives, etc. W. F. O'Keefe, G. G. Stiegler, E. E. Wright, Wilmington, Del.

The Automotive Corp., Dover, Del. Capital, $10,000,000. To manufacture engines, motor trucks, etc. Incorporators are Clement M. Enger, Elkton, Md.; M. V. Haywood and C. L. Rimlinger, Wilmington, Del.

The Babcock Scientific Paint & Oil Co., Newark, N. J. Capital, $125,000. To manufacture paints, etc. Incorporators are L. H. Graham, Scarsdale, N. Y.; A. H. Scarborough, New York City, and R. N. Schoemaker, Newark.

Bergman Co., Inc., Brooklyn, N. Y. Capital, $10,000. To deal in chemicals, dyes, paints, varnishes. W. J. Molinari, H. C. Ehrlich, S. Cohen, 31 Liberty Street, Manhattan.

Chonon Bernstein, Inc., New York City. Nominal capital, $5,000. To manufacture chemicals, etc. Incorporators are L. Scott and C. and E. Bernstein, 253 West 112th Street, New York.

C. Berthel & Co., Inc., New York. Capital $10,000. To deal in chemical drugs, Chinese articles. C. H. Berthel, R. Weller, A. Sharp, New York.

C. & C. Leather Co., Newark, N. J. Capital $75,000. To manufacture and deal in leather. Incorporators, B. N. Chanalis, V. O. Compalattaro and M. B. Chanalis, all of Newark.

The Cap Rock Oil & Gas Co., Chicago, Ill. Capital, $200,000. To engage in the production of oil and gas. Incorporators are W. C. Malone, W. O. Daly and J. G. Burns, all of Chicago.

The Carbon Products Co., Dover, Del. Capital, $120,000. To manufacture tar dyes, creosote and kindred products. Incorporators are M. B. F. Hawkins, J. G. Gray and H. M. Kennedy, Wilmington.

Conshohocken Steel & Alloy Corp., Philadelphia, Pa. Capital $250,000. Incorporators are F. R. Hansell, Philadelphia; J. V. Pimm, S. C. Seymour, Camden, N. J.

Crescent Chemical Corp., Elizabeth, N. J. Capital, $20,000. To make and sell dyes, etc. Incorporators are F. Curtin, H. O. Coughlin, A. W. Button, all of Elizabeth, N. J.

Crew-Levick, Jersey City, N. J.; to deal in petroleum products. Capital, $3,500,000. Incorporators, J. D. Baker, J. P. Murray, F. F. S. Saurman, all of Philadelphia.

Burt C. Crittsinger, Inc., Niagara Falls, N. Y. Nominal capital, $5,000. To manufacture paper, wood pulp, etc. Incorporators are B. C. and M. Crittsinger and H. A. Constantine, Niagara Falls.

Davidson Pipe & Iron Corp., Brooklyn, N. Y. Capital, $10,000. Incorporators, Ellis Davidson, Chas. Levine, Philip Levine.

F. A. Dillingham, Inc., New York City. Active capital, $30,000. To manufacture chemicals, etc. Incorporators are F. A. Dillingham, A. B. Champlin and R. P. Ballard, 17 West Forty-second Street, New York.

Dicks, David & Heller Co.; to make dyes and dyestuffs. Capital, $40,000. Incorporators, W. B. Walsh and R. H. Miller, Brooklyn; H. Rothkowitz and M. E. Schaefer, New York. Incorporated in Delaware.

The Goodrich-Lockhart Co., Orange, N. J. Capital, $250,000. To manufacture chemicals, etc. Incorporators are M. P. Coffin, W. J. Maloney and E. J. McWhinney, Wilmington, Del.

Helvetia Commercial Co., Inc., New York. Capital, $50,000. Incorporators are W. Saenger, Norman M. Behr, Elizabeth L. Clancy.

Jules Hirschfeldt & Co., Inc., New York City. Capital, $25,000. To manufacture chemicals, dyestuffs, etc. Incorporators are C. M. Allen, A. M. Nascher and C. Hirschfeldt, 644 Riverside Drive.

Jefferson Rolling Mill Co., Birmingham, Ala. Capital, $150,000. To manufacture mold, refine and prepare for market iron, steel, clay and metals, etc.

The Karosenc Paper Box Co., Newark, N. J. Capital, $25,000. To manufacture paper boxes and kindred products. Incorporators are Harry Karosenc and J. and B. Fishtrom, Newark.

Kutsche Machine & Foundry Co., Pittsburgh. Capital, $220,000.

Lewes Oil & Chemical Co., Wilmington, Del. Capital, $500,000. Robert Pennington, S. H. Baynard, L. A. Brownhill of Wilmington.

The Marquette Oil Co., New York City. Capital, $250,000. To develop oil properties and gas lands. Incorporators are S. B. Howard, John A. Moore and A. W. Britton, 65 Cedar Street, New York.

The New Process Rubber Co., West New York, N. J. Capital, $100,000. To manufacture automobile tires by special process. Incorporators are Reinhard Brueckner, West New York, and T. Schelberger and John Berger, both of Union Hill.

The New York Tool Manufacturing Co., Alpine, N. J. Capital, $25,000. To manufacture tools, etc. Incorporators are P. Turpeach, Brooklyn, N. Y.; A. F. Andrews, New York City, and S. Yankus, Alpine, N. J.

Ocoee Copper Co., Knoxville, Tenn. Capital, $100,000. To manufacture brass.

The Perfenol Co., Elizabeth, N. J. Capital, $50,000. To manufacture synthetic products of various kinds. Incorporators are K. C. FitzSimmons, R. T. Green and H. F. Ratigan, all of Paterson.

The Pittsburg-Oregon Mining & Milling Co., Grants Pass, Ore., has filed articles of incorporation, with capital stock of $2,000,000. A general mining and ore marketing business will be carried on.

The Seton Chemical Co., West Hoboken, N. J. Capital, $50,000. To manufacture chemicals. Incorporators are A. Murray, Arlington; Edward Murray and E. Saling, Newark, N. J.

The Straight Line Manufacturing Co., New York City. Capital, $20,000. To manufacture chemicals and kindred products. Incorporators are R. A. Van Vechten, G. H. Bensen and N. H. Phillips, 206 Broadway, New York.

The Tejure Products Co., Inc., New York City. Capital, $10,000. To manufacture chemicals and allied products. Incorporators are B. Jurist and D. and A. B. Tietjen, 513 East 118th Street, New York.

Tri-City Steel Co., Dover, Del. Capital, $1,000,000. To make iron, steel, etc. Incorporators are F. D. Buck, J. D. Brook, K. E. Longfield, Wilmington, Del.

United Ohio & Chemical Corp., Delaware. Capital, $2,000,000. To deal in and with oils, greases, tars, chemicals, etc. Incorporators are F. A. Armstrong, C. M. Egner, W. S. Randall, Wilmington, Del.

Construction and Operation

California

LOS ANGELES.—The Stauffer Chemical Company of San Francisco is to establish a big manufacturing plant here, preliminary building contracts already having been let to Leonardt & Peck, a local firm. It is said that the construction costs of the group of buildings to be erected will range from $80,000 to $100,000. The initial contract is for the foundation of the main building, a structure covering a ground area of 116 by 240 ft., to be one story in height and of concrete, lined with fire brick and with fire brick floors. All of the buildings are to be similarly constructed. Plans are being drawn in San Francisco.

RICHMOND.—A contract has been let to an Oakland firm for erection of the buildings of the American Carbon Company's plant in this city. Surveys of the site have been finished and work is ready to start. The plant will be one of the biggest of the kind in the country.

STOCKTON.—A million dollar paper mill for the manufacture of that special quality of paper used in the making of boxes and cartons is planned for this city. The factory has purchased 37 acres of land in the Boggs tract just west of the McDougal site. The machinery has been ordered, and actual construction will commence very shortly. The name of the company has not yet been made public.

Idaho

COEUR D'ALENE.—The Carbonate Hill and Idaho Giant Mining properties have been consolidated by Wilbur Greenough, and both properties are to be extensively developed.

KELLOGG.—The smelter of the Bunker Hill & Sullivan Mining & Concentrating Company has been assessed at $420,000 by the Idaho Board of Equalization.

Louisiana

NEW ORLEANS.—B. W. Seidel, president of the Dixie Steel Corporation, recently announced the purchase of a factory site, measuring about 500 by 963 feet on the New Basin Canal paralleling the tracks of the New Orleans Terminal Railroad and the Public Belt. The location will enable the corporation to transport raw material from the Alabama fields to its mill through the New Basin Canal.

President Seidel stated that building operations will be started as soon as the details have been worked out by the company's architect, Sam Stone, Jr.

Maryland

BALTIMORE.—The Baltimore Tube Company is at present turning out 1,000,000 lb. of copper and brass tubing per month. Work on the rolling mill is being pushed, and it is expected that it will be ready for operation around the first of the year. This plant will make copper and brass plates exclusively, and the company already is assured of a ready market for the product.

This mill complete will cost approximately $700,000 and will be paid for out of earnings. The new mill will be equipped to turn out 1,000,000 lb. of plates and rods a month or a tonnage equal to that of the tube plant.

Minnesota

MINNEAPOLIS.—Work on a new plant that will cover 40 acres and manufacture creosote oils and chemicals was begun recently in St. Louis Park by the Republic Creosoting Company, which now maintains a plant in Twenty-fourth and Marshall avenues.

The new plant will be constructed by 200 men on the former site of the beet sugar factory in St. Louis Park and will be in operation early in December, according to A. E. Larkin, the company's Minneapolis manager. The present Minneapolis plant will be consolidated with the new one.

The new plant will manufacture creosote oils, carbolic acid, napthaline and other chemicals from tar, which is a byproduct of coke ovens. The tar will come from coke ovens in St. Paul and many towns in Minnesota and the Northwest that have coal gas plants.

Missouri

KANSAS CITY.—Plans for establishing a $5,000,000 powder plant in Kansas City have about been completed, according to C. C. Palmer, a local realty dealer. As the representative of an Eastern firm already engaged in the manufacture of powder and high explosive chemicals, Mr. Palmer said he has an option on 118 acres of land adjoining and just east of the properties of the Standard Oil Company at Sugar Creek, which is to be used as the site for the plant.

ST. LOUIS.—The proposed investment by the Monsanto Chemical Works of approximately $750,000 in the erection of a new plant in East St. Louis was announced yesterday by the East St. Louis Chamber of Commerce. The company's main plant is at 1800 South Second street, St. Louis.

Negotiations for the purchase of about 90 acres of ground in the vicinity of Mississippi avenue and the Terminal Railroad Association's belt line have been closed, according to Joseph N. Fining, manager of the chamber. It is on this site that the St. Louis firm plans to erect a large plant for the manufacture of chemicals.

Montana

ANACONDA.—The Richmond Mining Company, which has been shipping a portion of its ore to the Montana smelter of the Anaconda Copper Company at Anaconda, and the remainder to Tacoma, is now shipping all of it to the Tacoma Smelter. The company is also negotiating for a rate which will permit shipments to the smelter at Greenwood, B. C.

ANACONDA.—The Montana Tungsten & Silver Company has instructed Supt. J. E. Walker to rush work on the Hidden Lake cyanide plant, in order that it may be ready before winter. All the equipment for the concentrator is on the ground with the exception of the boiler.

ANACONDA.—On August 24, the Anaconda Copper Mining Company announced a general shutdown of its properties in the state, following a strike of smeltermen at the Washoe Smelter at Anaconda. All of the mines of the company have closed, together with the smelter at Anaconda. The smelter at Great Falls will be kept in operation until the ores in transsit are disposed of when it is expected it will be closed. Of the three thousand men employed at the Washoe plant, only 110 have reported for work. That no fires have been allowed to go completely out in the Anaconda plant, is an indication that the existing shutdown will be a prolonged one. The mines in the vicinity of Butte are without facilities for storing ore, and with smelters out of business, it is expected that most of the larger mines will be closed down.

New Hampshire

PORTSMOUTH.—The plant of the Agricultural Chemical Company, which owns the Eastern Oil & Rendering Company and the Eastern McElwain Company's plants will be enlarged. A large brick building is being planned.

New Jersey

HARRISON.—Plans were filed recently by the Crucible Steel Company of America for a new press and forge shop in Harrison, to cost $390,000. The building is to be of steel and brick, and its dimensions are to be 222 feet wide, 427 feet long, and 132 feet high. It will contain an inner gallery 22 feet wide.

PATERSON.—The Society for Useful Manufactures sold several city lots on McBride avenue, adjoining the Hayes Manufacturing Company's plant, to the Fine Colors Company, for the sum of $6,370.

It is the purpose of the Fine Colors Company to erect a large mill on the property, the cost of which will be $20,000.

The Fine Colors Company manufacture newspaper colors, etc., and is at present occupying mill space in the old Gun Mill yards.

PATERSON.—The Commercial Chemical Company bought about twenty acres of the William T. Kyle estate, at East Forty-third street and the boulevard, adjacent to the Susquehanna Railroad, Paterson, as a site for a large plant.

RUTHERFORD.—J. Sterling Drake and Edward S. Brown have sold to the Burns Manufacturing Company two acres of land at East Rutherford, N. J., to be used as a site for a chemical plant. The property fronts on Paterson Plank road and the rear rests on the Erie Railroad, main line, with private siding into the property.

AUBURN.—Having completed the main buildings of its new plant for making crucible and electric furnace steel, the Cayuga Steel Company, Ltd., of Auburn, N. Y., is to begin operations with two 28-pot crucible melting furnaces and two electric furnaces, a hammer plant and rolling mill.

BINGHAMTON.—The Hire's Condensing Company, an adjunct of the firm which manufactures the famous Hire's root beer, has purchased a 13-acre tract of land north of Hillcrest in the village of Port Dickinson, upon which tract it is to erect a plant at an estimated cost of $500,000, for the manufacture of metal condensing utensils.

BUFFALO.—Contracts were let recently for the erection of a new chemical plant on South Park and Colcate avenues, near the new Commercial Electrolytic corporation plant. It will be of reinforced concrete, and the contractors have agreed to have certain of the buildings ready for manufacturing within sixty days. This new plant will be owned and operated by the Great American Chemical Products Company, a $10,000,000 corporation, with headquarters at New York. The Buffalo plant will produce pharmaceutical chemicals.

Ohio

TOLEDO.—A fertilizer plant to employ 200 people is to be erected in Toledo by the Royster Guano Company, which operates eleven plants in the United States.

A 7-acre site on the Michigan Central tracks in West Toledo was purchased by the company.

Work on the plant will start immediately. The Toledo plant will be the northern distributing center for the company.

Oklahoma

ARDMORE.—A $1,000,000 steel plant is proposed by Missouri capitalists, who have asked for donation of a site here.

Oregon

ASTORIA.—Astoria Pulp & Paper Company will start operation of their new $100,000 plant which is practically completed. Waste paper will be used and made into pasteboard. It is stated the entire output has been contracted for.

OREGON CITY.—The Terrell Silicia Mines near this city are to be developed and extensive improvements made to them. Company has contracted with a San Francisco Products firm to supply 100 tons of silicia monthly for the next year. Product has previously been used almost entirely by Clackamas County as a filler for paving.

PORTLAND.—The American Mining & Smelting Company has brought suit in the Federal Court in Portland, to enjoin the Bunker Hill & Sullivan Mining and Concentrating Company, an Oregon corporation, from smelting its own ores in a new smelter recently built at Kellogg, Idaho. The complaint alleges that the plaintiff holds a 25-year contract for the exclusive smelting of ores mined by the defendant company, and that the contract lacks 12 years of expiration. The contracts call for all ore containing from 30 to 70 per cent. lead. The new smelter of the Bunker Hill Company can handle ore with a content of less than 30 per cent. and more than 70 per cent, according to Bunker Hill officials.

SALEM.—The Natural Fireproof Lumber Company, composed of Seattle business men, has been formed to develop a huge deposit of volcanic tuff or lava at Mount Angel, Ore., near Salem. The product is claimed to possess remarkable fireproof qualities, and will serve as cheap substitute for asbestos or other fireproofing. Company has acquired 4,000 acres of the land, and will immediately develop it. It is capitalized at $100,000 and is composed of F. T. Crowe, W. L. Rhodes, John W. Eddy, A. Warren Gould and A. D. Coulter.

Pennsylvania

TEMPLE.—The new plant of the Temple Malleable Iron Company at Temple, several miles north of Reading, will be larger than expected. The buildings will include a one-story malleable iron foundry, 136 by 288 feet; a hard-iron mill 32 x 170 feet; one-story pattern shop, 36 by 90 feet; core house, 50 by 70 feet; power plant for operation, 65 by 140 feet. The buildings will be brick, steel and reinforced concrete, and the new work and equipment will cost $500,000.

Texas

HOUSTON.—The Empire Gas & Fuel Company will soon begin the construction of an oil refinery on the site recently purchased adjacent to the Houston Ship Canal. The proposed plant will cost about $2,000,000, and the company will receive its oil supply from the Gulf Coast fields of Texas and the Healdton field of Oklahoma. Its subsidiary, the Producers' Refining Company, which owns a refinery at Gainesville, Tex., is connected with the Healdton field by means of a pipe line. The Empire Gas & Fuel Company will build a pipe line from its proposed refinery near here to Gainesville, a distance of more than 300 miles.

Washington

INDEX.—The Sunset Mines, Ltd., is planning construction of a concentrator and ore mill at its mining properties. Mill will have capacity of 100 tons of ore daily.

SEATTLE.—The Presto-Lite Company, owing to the rapid growth in shipbuilding industries and consequent demand for the company's products, has increased its output more than 100 per cent. During the month of July, according to W. E. Darden, Manager, Seattle shipbuilding plants and industries using rapid oxyacetylene welding and cutting instruments, used nearly 660,000 feet of acetylene gas. Company uses more than three carloads of carbide each month.

SEATTLE.—The Puget Sound Pulp & Power Company has filed articles of incorporation, with capital stock of $16,000,000, and it is reported plans the construction of a large power plant and paper mill in the vicinity of Seattle.

SEATTLE.—While the steam vessels of the port commission are not in any immediate danger of being laid up owing to the fuel oil shortage, as the commission recently entered into a contract with the General Petroleum Company to supply this commodity for the ensuing year, an experiment in the use of powdered coal will probably be made in the near future.

George Nicholson, chief engineer of the port, at yesterday's meeting submitted a proposal to experiment with powdered coal as a fuel, and he was authorized to conduct such experiments on the ferry Leschi as soon as he deemed it convenient.

SEATTLE.—Forced to the expenditure of between $400,000 and $500,000 by reason of the approaching famine in fuel oil, the Puget Sound Traction, Light & Power Company decided to-day upon radical changes in its steam heating plant at Western Avenue and Union Street and in its steam electric power plant at Georgetown.

"At Georgetown at an expense of between $200,000 and $250,000, we will put in chain grates, or automatic stokers, in which to burn ordinary coal, instead of the oil which we have been using there," according to Vice-President W. H. McGrath.

"On Western Avenue we shall spend an equal sum in the enlargement and conversion of our plant, beginning the work just as soon as we can get the necessary materials. It should all be completed by next spring. The present building will be extended along its present lines to hold the powdering apparatus for our new fuel, for boiler and for equipment.

"Most of the money, however, will be spent inside of the present building. We have an oil contract that runs for another year, but we will not be able to get enough oil to carry on our increasing business.

"Therefore we plan to install an entirely new system that will involve the burning of powdered coal."

SEATTLE.—Confirming many rumors that a huge steel plant would be built on Puget Sound, Bart B. Thane, Alaska mining man and associate of C. C. Jackling, announced recently that the plant, requiring a capital of $25,000,000 would be built.

"Present labor conditions, high price of materials and difficulties of transportation are the factors holding back construction," he said. "When these matters are cleared away work will be started." Considerable San Francisco capital is interested in the plant.

VALLEY.—The Valley Magnesite Company, here, has announced that it will expend more than $100,000 in construction and development of a modern calcine plant. Irving Whitehouse, director.

British Columbia

GREENWOOD.—The Greenwood Smelter of the Canada Copper Corporation has resumed operations with one furnace, and will blow in a second furnace as soon as sufficient coke begins to come in. Company is smelting ore from the Mother Lode Mine and Lone Star Mine.

TRAIL.—The second of the four copper furnaces at the Trail smelter of the Consolidated Mining & Smelting Company at Trail, B. C., has been blowing in, owing to improvement in the supply of coke that is being received from Crow's Nest. First furnace was placed in operation August 1st, after the battery had been cold for many weeks, due to strike of coal miners. Company hopes to receive sufficient coke in the near future to permit of utilization of entire group of copper furnaces. An immediate result of the two copper gold furnaces in blast will be proportionate increase of shipment of copper-gold ores from Rossland. Rossland shipments this year have been curtailed because of coke troubles. The new concentrator at Trail smelter is reported to be working satisfactorily in the experimental dressing of Sullivan ores by the oil flotation process.

Alaska

JUNEAU.—According to statement of B. L. Thane, Manager of the Alaskan-Gastineau Development Company, $25,000,000 will be expended in wood and pulp mills in that vicinity, as soon as certain contracts can be sent from the Government regulating amount of raw materials. He asserts that such a plant could profitably be installed, and compete with Canadian mills and pulp plants on an equal basis. Engineers have been investigating the project for more than two years.

Metallurgical and Chemical Engineering

A Consolidation of
ELECTROCHEMICAL AND METALLURGICAL INDUSTRY and IRON AND STEEL MAGAZINE

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The Chemist and the Banker

The war is developing and emphasizing the importance in this country of new industrial relationships. It is showing the interdependence of apparently unrelated elements of business, and acquainting professional and commercial strangers with each other and with their common responsibility to the country. It is pointing out the fallacy of successful independent existence and teaching the moral of co-operative effort. It is resulting in a getting together for common as well as individual good, and the creation of an unwonted habit of familiarity where formerly only a bowing acquaintance existed. A variety of examples might be cited to prove the truth of these assertions, but for our purpose it is sufficient to record the fact that the chemist and the banker have met on the common ground of mutual appreciation of the importance of each in the scheme of industrial affairs.

With a background of the National Exposition of Chemical Industries, in Grand Central Palace, New York, able representatives of chemistry and banking addressed themselves to the problem of initiating a closer relationship between chemical industry and finance. The chemist stated his need of the banker, and the latter evidenced his appreciation of the importance of the former. The banker was brought to the scene of the chemist's triumph and acquitted himself with credit. Had the tables been reversed, or should they be reversed on a future occasion, we feel that the chemist would give equally good account of himself in a gathering of bankers.

The symposium came as a proper climax to a series of technical meetings held during the exposition. It had a tremendous human interest because of its bearing on our national life and growth. The chemist forsook his laboratory, which to the banker is probably only a smelly place where things are done mysteriously, and the banker left his counting house which probably is an awesome institution to many chemists. They spoke a common language devoid of technical terms and got together on the basis of practical business. The banker saw chemistry as a factor in commerce and industry and the chemist got a view of banking as a helpful agent in developing business.

We have considered these addresses of sufficient import to the nation's business to publish them in full on another page in this issue. They will prove helpful and inspiring reading to industrial chemists, and should give bankers a new view of a relationship which many of them have not cultivated. Since bankers as a class are not likely to read the articles unless called to their attention, chemists owe it as a duty to themselves and the industry to see that the proper occasion

is created for their bankers' edification. What industrial and engineering chemistry has done in this country is slight compared with the possibilities already appreciated by leaders in the profession. The demand is for an equally keen appreciation on behalf of that other factor which has yet to realize that chemistry will prove as much to his future advantage as trade and commerce have in the past.

Improvement in Tungsten Milling

In view of the importance of tungsten in modern metallurgy it is a satisfaction to record the reports reaching us regarding recent improvements in recovering tungsten mineral from the original ores. This is with special reference to Boulder county, Colorado, which, as is well known, is one of the important tungsten-producing regions of this country and of the world. In order that the situation may be fully appreciated, the development of the tungsten industry in Colorado must be considered from the time when an unknown, troublesome, black, heavy mineral bothered the early gold miners of that region. It was as unwelcome there as was the carbonate of lead to the pioneers of Leadville, but likewise it later became the basis of a flourishing industry.

Quite naturally those who took early advantage of the demand for tungsten were the one-time gold miners and millers of that region. Equally as a matter of course, these men applied their gold-milling equipment to the concentration of tungsten ores. Stamps and bumping tables had been standard equipment for gold milling, and these devices in modern form were applied to the new problem. Slime recovery had been fairly well accomplished with stationary canvas tables, and these were added when it was found that tungsten minerals slimed badly in the stamps. Thus a practice was established without due regard to the new conditions, and the results were not the best. Early ideas proved tenacious, however, and in some new mills built within the past decade, stamps, tables and canvas plant comprised the means of grinding and dressing the ore.

Engineers then began to point out the futility of grinding a friable mineral to slime in a stamp mortar and attempting to make a satisfactory recovery on canvas. They showed that the ores comprised a hard gangue and a soft, heavy mineral, and that the latter remained in the mortar until it was pulverized. In this condition it was subject to heavy losses on any form of concentrating table.

The logical remedy suggested was roll-crushing and jigging; but jigs were more or less of an unknown quantity and a decided innovation. The suggestion was not welcome at first, but latterly it has been adopted and we are informed that the last stronghold of the stamp has fallen and that roll-crushing is now standard practice. In combination with jigging, which also has been generally adopted, roll-crushing avoids initial fine grinding and permits early recovery of the mineral in coarse form. The resulting improvement is true conservation of the metal.

Alizarine

Two young Jack Tars in U. S. Navy uniforms halted at the booth of a chemical engineering corporation at the Exposition in the Grand Central Palace. They conjugated their verbs properly; they did not say "subsidery" for subsidiary or sharpen the letter *s* beyond the custom of good English; in short their speech bore that quality of grace which classicists claim is best obtained by the study of the humanities.

"Sir," said one of the pair to the man in the booth, "when may we have uniforms dyed with fast colors? We are about to desert unless these be shortly forthcoming."

The man in the booth was raised Presbyterian and was accustomed to hear sermons preached. He also knew his Boswell. "Oh, my young friends," he responded, "do not do that evil thing. In yonder booth" (pointing to the du Pont exhibit) "they are already taking orders for indigo and there" (pointing to the National Aniline display) "they are accepting commitments for delivery next year. I am assured that real alizarine reds and blues, made from anthracene, will soon be produced and then you shall have no more trouble on this score. Let me urge upon you as you value the honor of our common country," etc., etc.

"Thank you, kind sir," answered the second, "we are now resolved to observe your admonitions and to follow your advice. You have saved us from the sin of desertion," etc., etc. The little party continued to amuse itself for five minutes or more in XVIII century fashion. But the man in the booth did not tell them how often he had been assured about alizarine colors, nor did he say that no preparations to make them appear to be in sight as yet.

American manufacturers of synthetic dyestuffs have done wonders in meeting the demands of the textile industry. By Jan. 1 we are informed that a good cotton vat blue, something of the indanthrene type, will be offered for sale and from that to the other fast cotton colors is but a short step. The yellows and reds and greens will soon follow. One American company is already making a ton of 20 per cent indigo paste a day and it makes also dibromindigo, which is an improvement. The products needed to avoid the unhappy substitutions now practised by dyers—by force of circumstances alone—are coming upon the market, one after another as the months go by, always excepting the real alizarine colors. Para red (from paranitraniline) is called Turkey Red and the way fabrics dyed with it smear things up is a matter of despair. American-made colors will not get over their reputation for instability until we have these splendid standard alizarine dyestuffs in plenty.

There is abundance of anthracene at hand and as much more will be produced as is desired; the oxidizing chromates are available, the talent to produce is here—in short everything is to be had except the plant. The equipment required to make alizarine is considerable and expensive but the undertaking is not as serious as that to make indigo. Of course, development has been

held back by the trick of Congressman Claude Kitchin of North Carolina who juggled the specific duty off of alizarine products in the Hill bill. The Honorable Claude can now have the satisfaction of looking at the dirty necks of Uncle Sam's Jackies and saying "I did it," for it goes without saying that if the specific duty had been allowed to remain on alizarine products as originally provided in the bill, these products would have been on the market to-day.

The colors could be made and sold now at a profit. What Congress will do when the war is over remains to be seen. We may, according to the men we elect, get a lot of reactionaries there who will want to throw down the bars and let foreigners dump dyestuffs and other products into the United States to their hearts' content and break up the whole industry here. The point is that there is an intense crying need for alizarine in this country now; we mean real, genuine alizarine; and if it can be made and sold at a profit—and it can—this should be done in spite of an individual Congressman.

Price Control of Iron Industry

Price-fixing in the iron and steel industry, inaugurated as to Lake Superior iron ore, steel bars, shapes and plates and certain descriptions of pig iron by the official announcement at Washington on Sept. 24, and being extended to practically all commodities in the industry, has been accepted by substantially all producers as a satisfactory remedy for the very undesirable market situation that existed. Buyers of steel, in the main, are well satisfied, but a few, lacking vision or mental equipose, have suggested as an objection to price-fixing that they find themselves unable to buy at the new prices. That, however, shows one great need for price fixing, since if producers are unwilling to sell at the fixed prices, an open market would expose the individual buyer to the evils of competitive bidding.

One cannot help wondering whether the satisfaction the iron and steel industry expresses over the arrangement that has been concluded has any connection with its oft expressed desire that it should be allowed to control its market, preventing prices from going too high in times of excessive demand and from going too low in times of inadequate demand. Perhaps it is thought that the experiment will work so well that the Government will be disposed to continue the practice after the war.

There is no reason at this time to assume that the Government will be so disposed. The Government has subscribed to no new principle, adopted no new doctrine. It simply explains a definition already adopted, regarding competition. The Sherman law, for instance, was enacted to preserve competition. Now all that is necessary is to explain that competition between sellers was meant, and it was competition between buyers that dictated the resort to Government price-fixing.

Nevertheless it is permissible to look upon iron and steel price-fixing as something which, while adopted purely as a war measure, may give such a good account of itself as eventually to suggest the desirability of its being continued, in one modified form or another, when peace returns. That would be natural, and altogether in line with many other things. Countless inventions, mechanical and chemical, have been forced by the stress of war, and no one would think of forgetting them after the war.

It must be recognized that price-fixing is not the only procedure in the Government's dealings with the iron and steel industry. In one respect it is only a subsidiary act. The Government requires that all the steel the industry can make that can be used by itself or its Allies must be produced before anything else is thought of. It is highly desirable that such operations of the people as conduce directly or indirectly to the prosecution of the war, such as the raising and transporting of crops, be facilitated by being supplied with steel as next in order, and that last in order be such supplies of steel as have no connection whatever with the immediate prosecution of the war.

To accomplish this end the Priority Board was recently constituted, to determine the order in which steel and other commodities shall be produced and shipped. To facilitate this work a schedule of prices is adopted, to apply upon all purchases. Thus it will not be materially more profitable for a mill to fill one order than another. In this respect price-fixing is subsidiary to the priority regulation.

It is very generally admitted that the price basis adopted is entirely fair to the iron and steel producing industry. Well it may be, considering the comparison the basis prices make with the average market during the ten years prior to 1914. These prices exceed the ten-year averages by the following amounts: Pig iron, 110 per cent; steel bars, 106 per cent; shapes, 99 per cent; plates, 117 per cent. If such prices were not high enough to produce large profits, resulting in heavy war taxes, it would be imperative to attack the cost of production from whatever angle necessary.

The Government is not done when it has established fixed prices and the priority shipment system. The priority system merely provides a sequence in which orders shall be filled. It does not in itself control or stimulate the production of any given material. That is more or less implied, but in the final working out the Government will undoubtedly be found to be going much farther than merely establishing the sequence in which orders shall be filled.

When the Government has finished decreeing what shall be done for it, there remain some obligations on its part. The dealings began by a mutual agreement, the authorities having power through legislative enactment to fix prices the Government shall pay for material it buys, while the producers conceded that they would charge the same prices to the Government's Allies and to the general public. In an open market, a shortage of steel results in higher prices, and if the ouput is less than the capacity, there is a compensation in higher profits per ton for the fact that the number of tons is less. With a fixed price there is no such compensation, and the Government should employ all the resources at its command to stimulate the production.

Readers' Views and Comments

Invention and the Flotation Suits

To the Editor of Metallurgical & Chemical Engineering

Sir:—We now have heard many decisions of our courts, practically all sustaining the theory and practice broadly of the patents of Sulman, Picard & Ballot owned by the Minerals Separation Company.

We read many opinions of corporation engineers, and editorial commentators, to the effect that the courts are mistaken.

It appears wrong that business interests should control and exploit purely for mercenary gain valuable basic patents, but no more wrong than that industry should seize a basic inventive thought and practice and make fabulous wealth, and decline to share with research. We hear nothing about the inventor or community benefit or the purpose of patent law or that the patent laws are wrong, or should not exist. For more than a generation our patent laws have been kicked about like footballs, the force of money being used to defeat the equity of invention. Only through exploitation by capital interests can an invention be defended and become an asset to the owner.

It is just possible that the law of action and reaction is about to assert itself, and an equity balance is to be established by broad legal rulings. If this is so the results of research will become assets with recognized rights, and not mere chattels, which the inventor cannot use for the benefit of himself or his ideal, research, and the best public utility.

To say that there is no invention in the art of flotation as disclosed by the research of one of Sulman, Picard & Ballot, would be to deny one of the greatest metallurgical industrial advances of the generation. There was no practical art previously with no community benefit.

It is true that corporation engineers have adopted and applied, and their employers reap the benefit.

The patent law says that the inventor shall have a monopoly protection for a period as incentive. He should be forced to permit public use, but always is more than desirous of such.

A royalty should be paid him as the only good solution of business relations in common commodity inventions.

Somebody or mind must set the ball in motion, and such person is the inventor as declared by the U. S. Patent laws. Others who have found the ball too heavy to start, and those who help just after motion, are not the creators of the motion, which is the analogy used for invention. If the community wish some different form, the patent laws must be changed. Whether the profits are justly or unjustly distributed is no part of the courts in deciding patent standings, they are called up to decide in marked cases like the flotation art, as to what was the cause of industrial motion, which gave community benefit.

The inventions of S., P. & B. stand out prominently and must be considered basic after a Supreme Court decision. If there is now invented a decided advance it must have individual rights, but so far we see only acknowledged evasions based on literal readings of decisions attempting only to define results by means of a degree, or we see other means creditable and patentable in themselves being advanced as displacements of the original conception, but producing largely the same result.

Who is there among the engineers and editors who condemn our courts, who will show where industry will ever make any equitable proposition to an inventor recognizing his asset?

If industry would deal direct with research or through some clearing house, and not attempt to clip the wings before and after the act, few inventors would be forced to assign to capital or industry in order to get the small share they may receive; litigation would largely cease, because patents would not be used as financial clubs, and the community would be better served, because the common suppression of invention for business reasons would largely be prevented.

The inventor or his affiliated interests are usually the safest custodians in whom titles can be rested, and much more usually do they apply any increment to further research desired by community, and are best able so to serve. Analysis would seem to show that industrial greed or money power is the monster, not the courts, patent law or the inventor.

It is highly desirable for industry to meet Minerals Separation in some proper way to stop such useless litigation; but like the world war, if a lesson can be learned so to organize as to prevent future waste and serve community interests, the struggle will not have been in vain. Kings and oligarchies can never rule an enlightened people properly, any more than industry or capital interests can control research without great friction and waste. Research and invention is the light, the advance; it cannot be led, pushed or forced, it must find the way and be free to do so.

Parker C. Choate.

Essex, Mass.

Temperature Calibration of Glassware

To the Editor of Metallurgical & Chemical Engineering

Sir:—It is often necessary to make up solutions of standard volume when water of the desired temperature is not available. Some of the work encountered in commercial laboratories requires that the solution be made up to a definite volume, so that aliquot portions may be removed. If these portions are all taken at the same temperature as that at which the solution was diluted to its volume, there is no resulting error. However it is sometimes necessary to take the samples at different times, and if the solution changes in temperature between these samplings, an appreciable error will be introduced. At other times it is desired to make standard solutions from weighed amounts of materials, and in order to secure an accurately made solution it is necessary to allow the solution to come to the standard temperature before filling the flask to the mark.

It was found that volumetric apparatus may be calibrated with respect to temperature. For example, a liter

flask may be marked with its original calibration at 20 deg. C, and in addition may be marked to show the volume that that amount of water would have at temperatures from 15 to 35 deg. C. Pipettes may be treated in the same way, and with such apparatus the above errors may be eliminated. If the water at hand has a temperature of 31 deg. C, the flask should be filled to the corresponding mark. At any time thereafter, true aliquot portions may be withdrawn by the pipette, by simply noting the temperature at which the sample is taken, and filling the pipette to that mark.

The methods of standardizing at different temperatures are exactly similar to methods used at any standard temperature. For approximate work, the flask may be filled under its standard conditions, stoppered, and heated or cooled through the temperature range desired, suitable markings being made at regular temperature intervals.

The use of such apparatus results in eliminating either the waste of time of securing water of standard temperature, or the errors caused by using water at indefinite temperatures.

W. A. WISSLER.

Cambridge, Mass.

Western Metallurgical Field

Electrometallurgy in the Northwest

Considerable attention is being devoted to the prospect for electro-metallurgical development in the Northwest. At the present abnormally high prices for electro-metallurgical products, the time is most opportune for launching ventures which promise even moderate success. Of course, the first cost of plant now would be high, but at the present extremely high prices for the product, a really good development should be able to write off this first cost within a few months. Furthermore, plants started now should be able to pass through the experimental and adjustment stage in a time when the highest economy and efficiency of process is not vital to financial success.

These conditions, however, have drawn into the field a number of companies, for the most part still in the promotion stage, whose chief purpose seems to be a short cut to the profits. Such ventures are usually not attended with development along permanent lines. Almost any plant and an inefficient process make money now, but when prices come down again the plants which were hastily planned without competent supervision will not be able to continue and their failure will reflect harmfully upon the industry.

It is, therefore, well that new ventures in this field, even in the present favorable times, should be launched only upon the advice of competent experts. The questions which are given first importance now in the Northwest are: (1) Is there enough raw material to warrant the development of a permanent plant? (2) Can it be reduced so as to make a profit at post-war prices? and (3) Considering the development on a permanent basis, what equipment should be installed and how shall the process be developed so that the greatest financial returns shall ultimately accrue?

It is interesting to note that in the Puget Sound region, eight electric furnaces for the reduction of steel scrap have recently been put in operation, two of these are three-ton capacity and the others are smaller. Two other plants, to be built somewhat along the same lines, are under construction and still others are contemplated. One company in Portland, Ore., is using the electro-metallurgical process for ore reduction and is now producing ferro-manganese.

Important Litigation in the Coeur D'Alenes

The American Smelting & Refining Co. has filed suit in the Federal Court at Portland, Ore., against the Bunker Hill & Sullivan Mining & Concentrating Co. of Idaho, asking that the defendant be enjoined from operating its recently constructed lead smelter at Kellogg, Idaho, and be compelled to fulfill a contract entered into with the plaintiff for the sale of lead ore and concentrates. The complaint reviews the relations between the two concerns with regard to a 25-year contract made in 1905, wherein Bunker Hill agreed to sell to the plaintiff's Tacoma Smelting Co. all the output of its mine carrying from 30 per cent to 75 per cent lead. For this product the plaintiff was to pay for 90 per cent of the lead content and 95 per cent of the silver, and the contract was to be subject to revision at five-year intervals. It appears that at the second revision period, in 1915, Bunker Hill made a demand for more favorable rates, which were refused, whereupon it proceeded to erect its own smelter at Kellogg for the reduction and refining of its output. This plant was put in operation about July 15, 1917. Plaintiff now seeks to enjoin Bunker Hill from operating the plant, and asks an order compelling specific performance of contract.

Chloridizing Flotation Concentrates at the Buffalo Mill, Cobalt

The Buffalo Mines, Ltd., Cobalt, Ontario, Canada, was the first company in that district to adopt and operate the flotation process on mill tailings. The Callow pneumatic system was adopted, and after due experimentation a 600-ton plant was built for the treatment of the daily mill production of 150 tons, together with 450 tons of old tailings. According to the annual report of Arthur A. Cole on the mining industry of northern Ontario, the plant is simple, consisting of tube mills in closed circuit with Dorr classifiers, four two-compartment triple-length Callow cells for roughing, and four two-compartment cells for cleaning the rougher product.

The cleaner cells make two products, a concentrate which is sent to the "high-grade" mill, and a tailing which is treated in the "low-grade" cyanide plant. The treatment of the concentrate is an interesting departure from methods hitherto used in the Cobalt district, and consists in a combination of chloridizing-roasting and cyaniding. The concentrate first is treated with 30 lb. of lime per ton, thickened in a Dorr thickener and filtered on an Oliver filter. Salt is added, partly as a brine wash and partly as solid. The concentrate is then dried, and, after further addition of salt and sulphur, is roasted. The roaster first used was a reverberatory, but it is reported that a Holt-Dern shaft roaster, of the type developed and used in chloridizing Utah ores, is to replace the reverberatory. The roaster product is given a wash with a 13 per cent hydrochloric acid solution and passed over scrap iron for precipitation of copper. The pulp is washed and agitated with a 15-lb. cyanide solution

in which silver chloride dissolves rapidly. The pregnant silver solution is precipitated by sodium sulphide, and the precipitate is refined in an oil-fired reverberatory furnace.

Substitutes for Platinum

The importance of platinum in chemical and metallurgical work, and the prevailing high prices for the metal, have led to investigations for successful substitutes. Two such products, alloys of gold and palladium, have been placed on the market in various forms for laboratory use, and have been receiving the close attention of chemists. As far as can be ascertained at the present time, the new alloys are giving satisfaction in many lines of work, notably in smelter and metallurgical laboratories, in the form of dishes for evaporations and fusions, and as cathodes for electrolytic analysis. When used with reagents other than boiling concentrated nitric acid, alloys of appropriate composition may be chosen to give service equal to or better than that of platinum. This is especially true in the case of boiling concentrated sulphuric acid.

In appearance the alloys are practically white, and it is with difficulty that they can be distinguished from platinum. This fact has opened the way for deception in disposing of supposed scrap platinum, and for this reason some companies have temporarily discontinued buying the latter material or making allowance for it on new ware.

An item of importance in the substitution of these new alloys for platinum is their lower cost. With large companies operating a number of laboratories, this becomes a consideration, for at present prices the platinum equipment can be disposed of at an appreciable profit. Another factor is that there is less probability of theft of the cheaper alloys than of the expensive platinum. While thefts of platinum are not heralded abroad, they have amounted to a considerable sum in schools and laboratories in the last year or two.

Coming Meetings and Events

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Plans Discussed for Next Chemical Exposition

The Advisory Board of the Chemical Exposition held a meeting at the Chemists' Club on Sept. 29, at which plans were discussed for next year. It was an enthusiastic and inspiring meeting and great satisfaction was expressed with the wonderful exposition held this year. Several improvements for next year were discussed, resulting from the experiences gained this year. Those present were C. H. Herty, chairman; M. C. Whitaker, H. B. Faber, A. D. Little, R. P. Perry, L. H. Baekeland, F. W. Payne, C. G. Fink, B. C. Hesse, G. W. Thompson and C. F. Roth.

Société de Chimie Industrielle

A society of Chemical industry has been formed in France and will be known as the Société de Chimie Industrielle. Lieut. René Engel, a member of the French Scientific Mission to the United States, is secretary of the society. He, together with Professor Grignard of Nancy, were interested guests at the Boston meeting of the American Chemical Society and the Chemical Exposition.

Through Lieut. Engel's efforts the French Society and the needs of chemistry in France have been brought before several representative American chemists, and Dr. Jerome Alexander, with the co-operation of many representative American chemists and manufacturers, has started a movement to form an American section to the French Society. He points out that it is not a question of needing more chemical societies in this country, but that France needs our moral support in order that chemistry may play a more important part in the nation. We should not hesitate to lend this helping hand when it is so badly needed.

A circular has been formulated and will be sent to the chemists and manufacturers in this country. The first part of this circular follows. The letter of the president and the abstract of by-laws are not included here but will be included in the circular:

To the Chemists and Manufacturers of America:

There has been formed in France a French Society of Chemical Industry, the Société de Chimie Industrielle, whose objects are fully set forth in the attached letter of Mr. Paul Kestner, President of the Society.

After consultation with Mr. René Engel, Secretary of the Society and a member of the French Scientific Mission in the United States, the undersigned committee believes that it would be most opportune to establish an American section of the SOCIETÉ de CHIMIE INDUSTRIELLE, and thus extend to our French fellow chemists and manufacturers our moral and financial support and the right hand of good fellowship.

Furthermore, members of the American section will benefit by the closer relations which will naturally develop between American and French Chemical Industry.

An abstract from the By-Laws of the French Society is hereto annexed, together with application for membership in the American section, which should be filled in and returned to the Committee:*

Jerome Alexander	Frank Hemingway
Leo H. Baekeland	Elwood Hendrick
Raymond F. Bacon	Charles Herty
Wilder D. Bancroft	J. B. F. Herreshoff
Charles Baskerville	George F. Kunz
Albert Blum	Parker C. McIlhiney
Henri Blum	William H. Nichols
Marston T. Bogert	Charles L. Parsons
M. Cérésole	Charles L. Reese
Arthur M. Comey	Allan Rogers
Charles A. Doremus	Samuel P. Sadtler
John V. N. Dorr	Maxmilian Toch
William M. Grosvenor	Gustave W. Thompson
Christian B. Zabriskie	

Information in regard to the American Section should be addressed to the Organization Committee of the American Section of the Société de Chimie Industrielle, care Chemists' Club, 50 East Forty-first Street, New York.

*These By-Laws and the President's letter are included in the circular.—Ed.

St. Louis Meeting of the American Institute of Mining Engineers

The war-time convention of the American Institute of Mining Engineers which opened at St. Louis, Oct. 8, was notable for its patriotic spirit and atmosphere as well as being the largest meeting in the history of the Institute. The meeting opened with a patriotic session which was presided over by President Philip N. Moore. Secretary Stoughton read the following letter from Sir R. A. Hadfield, honorary member:

"Just a few lines to say that a magnificent reception was given to-day to your troops marching through London. God bless America. To-day has been epoch-making in the history of the Anglo-Saxon race. Whilst we English may not show our emotions as freely as others, America's activity in the course of the war and the splendid way she makes preparations touched deeply the hearts of my countrymen and all of us."

This was followed by a message from Herbert C. Hoover:

"Urge upon members that they preach and practice the gospel of saving, service and sacrifice. This must be brought home to every citizen if we are to emerge from this cataclysm a unified free people. Government indebtedness can only be paid from savings. We must make whatever sacrifice necessary whether in our own personal expenditures or as volunteers in national service or supreme sacrifice as soldiers in trenches to make the world safe for democracy. We must all save, serve and sacrifice."

Henry M. Ami in bringing greetings from the British Legation and the War Mission said that the fact that the United States had entered the war was the greatest asset of the allies. He called France, Great Britain and the United States the world's granite nations, most durable and strongest. Carrying out the simile he likened the French to mica, polished and smooth, the British to quartz, with its grit and durability and the United States to feldspar as a composite. Each of these is necessary and useful to the formation of a peace league that will endure forever.

Lieutenant Colonel DeBilly of the French Commission showed how France and Russia were forced into the war by invasion, England to protect Belgium and America as a result of ruthless submarine warfare. All are fighting for independence. Various past wars have emphasized different needs. The Boer war showed the importance of shelter, and the Manchurian war of munitions. The present is a war of engineers and therefore we find them enlisted in making roads, trenches, saps, mines and communications and in industry producing raw materials and munitions. He stated that trench life was one of democratic discipline and was not antagonistic to friendly fellowship. Officer casualties have resulted in 80,000 merit promotions from the ranks. Speaking of the tremendous future work of rehabilitating the invaded districts of Belgium and France he felt confident of America's ungrudging help.

Fedor Foss of the Russian Commission said that at the outbreak of the war the offer of aid from scientists and engineers was refused by the Russian beaurocracy. After eight months' negotiations, however, when lack of munitions on the Galician front brought disaster and retreat, the organization of public war industrial committees was allowed, in which all intelligent forces were needed for the production of materials and munitions. The old Government was suspicious and obstructive, as indicated by orders recently found cancelling steel shipments to co-operating concerns. America's help has been invaluable, since three-fourths of the necessary machinery has come from this country. Russia has also commenced the mining of tungsten, and the smelting of zinc, lead and mercury. It has also tripled the production of sulphuric acid and has expanded the platinum industry. The mobilization of 15,000,000 soldiers has deprived Russian industry of its best men and a shortage in raw material has been averted only by strenuous effort. But the army has now all prime necessities, and following the temporary demoralization due to the revolution and the subsequent elimination of internal enemies, the success of the Government seems certain.

F. W. DeWolf reviewed the organization of American civilian committees and boards, and showed rapid evolution and real progress in spite of mistakes, jealousy and misinformation. In his opinion final victory would come not to a temporarily perfect war machine but to the nations receiving the spontaneous effort of all citizens.

Chairman Westervelt of the War Minerals Committee reviewed the work of that organization and stated that there was an urgent call for sulphuric acid makers to use pyrrhotite and marcasite in place of pyrite. Those who can or will use the first mentioned minerals are requested to forward their names to the American Institute of Mining Engineers, New York, or U. S. Geological Survey, or Bureau of Mines, Washington, D. C.

David White of the Geological Survey related recent activities in mapping, investigating and reporting the mineral production of the United States. He stated that picked drafted men has been detailed as topographers to fill the ranks of the Survey. A. G. White of the Bureau of Mines, and Secretary of the War Minerals Committee, described in detail the activities of the organization and explained that present efforts were directed only toward the most obvious necessities.

W. O. Hotchkiss electrified the assembly by stating that it was imperative that each should realize that "this is my war." We are fighting an enemy who knows his resources minutely, whose Government organization, scientific activity and industrial expansions have been created and controlled to wage a successful and terrible war. We are scattered and are approaching a crisis unprepared and unarmed. Everyone should ask "Am I doing my share?" and should do anything he sees to do without waiting for instruction. We should also ask, "Is the Government doing all that it can?" and then see that it does.

Session on Milling

The Hancock Jig in the Concentration of Lead Ores was presented by HAROLD RABLING, of St. Joseph Lead Company. His notes were based on a standard 25-ft. Hancock jig tested in regular operation in the Bonne Terre mill of the St. Joseph Lead Company. The reason for the investigation was the crowding of the circuit due to the return of re-crushed middlings. The tonnage in circuit grew to such enormous proportions that it became imperative to either decrease the amount of middlings or provide more crushing capacity. Investigation was accordingly made of the jigs, including speed, length of vertical and horizontal strokes, depth of bed, size of grains forming the bed, and specific gravity of those grains. As a result of the study, more efficient jigging was done and the tonnage was raised from 1800 to 2200 tons per day without increasing jig equipment.

Discussion of this paper brought out the fact that jigs throughout the district receive three-quarters of the total original feed, the balance going to tables and flotation apparatus. Jig losses are from three to four times those from tables. The circulating load may build up to a point where it equals the original feed.

Concentration Practice in Southeast Missouri was thoroughly covered in an elaborate paper by Mr. A. P. WATT, giving data on crushing, grinding, screening, jigging, classification, tabling and flotation.

The concentration problem of the district is to save the galena and discard the other metallic minerals. The concentrate must be as clean as possible, not only to save smelting charges, but also to permit the smelters to handle efficiently the concentrate, particularly if the Scotch hearth be used. The galena should be recovered in a size as large as possible.

Hand-picking is not generally practised but is advisable to some extent in order to prevent large quantities of gangue from wearing the mills unduly. In the field of crushing the usual practice is to use gyratories as primary machines, followed by Symons crushers or rolls. There is nothing of special interest about roll practice in the district.

In classification and tabling, the introduction of the Butchart table has done much to simplify practice. Classifiers generally have been eliminated and replaced by apparatus for desliming only. The problem of table treatment is simplified due to the difference in the sp. gr. of galena (7.4) and dolomite (2.85).

Considering the subject of regrinding machines, the author considers the Marathon to have advantages over ball mills. The line contact between the rods gives positive crushing, and the use of rods instead of balls permits use of less power for equal weight of crushing metal. Steel consumption is less and the wear on the liner negligible. The rods must be removed when worn, otherwise they are likely to bind into bundles or coil like springs. Rods wear more rapidly at the discharge end of the mill.

Present methods of slime treatment include both gravity processes and flotation. Numerous types of flotation machines are used in the district. The flotation concentrate is filtered, yielding a cake containing about 14 per cent moisture, which must be dried. The problem of drying has been satisfactorily solved by the Lowden dryer. Since the cost of flotation is many times that of tabling, and the flotation concentrate lower grade than table concentrate, every effort should be made to minimize the tonnage treated by flotation.

The Milling Practice of the St. Joseph Lead Co., by L. A. DELANO was printed in our issue for Sept. 15. To the information therein contained, Mr. Delano added some data on the Allen cone. The coarsest concentrate handled is through 9 mm., with a complete range of sizes; the coarsest sand through 2 mm. A 4-ft. cone handled 145 tons per day, with an overflow containing 97 per cent of solids minus 200-mesh. The spigot product carried 30 per cent water and 5 per cent solids minus 200.

Ore Dressing Practice in the Joplin District, by C. A. WRIGHT, of the U. S. Bureau of Mines, contained a condensed statement of the author's study over a period of several years. The paper was praised as being the first adequate presentation of conditions in the district. The general practice at Joplin results from small ore bodies and short leases, and fits conditions very well. Some of the data embodied in Mr. Wright's study were published in this journal, Sept. 15, 1916.

Tuesday Sessions

The program for Tuesday, Oct. 9, included a morning session on lead, a boat trip to Herculaneum to visit the smelter of the St. Joseph Lead Co., and an evening session on miscellaneous subjects.

The rôle of **Salt in the Metallurgy of Lead,** as presented by Messrs. O. C. RALSTON, C. E. WILLIAMS, M. J. UDY and G. J. HOLT, has already appeared in abstract in our issue of Oct. 1. Discussing the volatilization process for oxidized silicious lead ores, Mr. E. L. BLOSSOM stated that laboratory tests had yielded an extraction of over 90 per cent in one hour, but that a reverberatory treatment required eight hours, and yielded only 75 per cent extraction. The White revolving kiln increased the speed of reaction, but lack of ventilation builds up a vapor pressure in the interstices of the ore, damping volatilization. The blast-roast may afford a solution of this problem.

C. L. LARSON questioned some of the chemical statements in the author's paper, on the basis of extensive successful work at the Bunker Hill property in Idaho. Details of this will be published later.

ARTHUR THACHER referred to the early days of leaching processes, such as the Ziervogel, in which the delicate roasting of silver ore preceding hyposulphite leaching was successfully conducted, with a resulting extraction of better than 90 per cent. He thought that physico-chemical investigations were needed, and suggested that the Stedefelt shaft furnace would be useful in this work, giving a short contact under favorable conditions.

The Metallurgy of Lead Ores in the Lower Mississippi Valley, by HERMAN GARLICHS, presented at this session, has already been published in abstract in our issue of Aug. 1. The trip of the Institute to Herculaneum afforded opportunity to see the practice described.

Increasing Dividends Through Personnel Work is the title of a paper by THOMAS T. READ, in which he outlined the nature and necessity of more attention to human engineering in industry. He defined his field as follows:

Personnel work is a term recently introduced to cover the great variety of activities in industrial work

that deal with the human factor. Much attention has been focused upon individual phases of personnel work, such as accident prevention, sanitation, "welfare" work, reducing labor turnover, and so on. In most cases these activities have been carried on as though they were distinct and separate fields; as a matter of fact, they are only different phases of the single problem of human engineering, and each has important and fundamental relations with the others. Thus, for example, high labor turnover is one of the most important causes of a high accident rate, and unsatisfactory housing conditions are an important cause of labor turnover. In the early stages of the study of these problems it was necessary to take them up separately; the time has now arrived at which it is desirable to consider them as a whole, in order to bring them into the right relation to each other. When thus considered as phases of an interrelated whole, they may be grouped as personnel work.

As a result of his study of the problems involved in this work, the author reaches the following conclusions:

Labor has become the largest cost factor in productive industry, and seems likely to continue its relative increase. The ideal of industry is a laborer who is sober, efficient and steady. The first is in progress of attainment by the advance of prohibition of the liquor traffic. Efficiency in the workman is attained through better management and training of the worker. Lost time is overcome by the prevention of accidents and illness, and through a great variety of means that bear indirectly, as indicated above, on the labor supply. Industrial accident prevention looms large in the public eye through the recent enactment of compensation laws, but as a source of lost time to the plant and lost wage to the worker it is much less important than illness. Health insurance is now being urged in many quarters, and if it comes about we may expect a transfer of emphasis from accident to illness prevention. Lost time through religious holidays and other personal activities, or inactivities, of the worker, is much more important than either; their relative values being something like 1, 4 and 10 in most cases. The only practicable means of dealing with the latter seems to be the offering of a bonus, over and above wages, to the workmen who lose no time each month. The underlying purpose of personnel work is to conserve the labor supply and decrease the net cost of productive labor. Personnel work is human engineering; it requires natural aptitude and special study, and is not a field for the well-meaning amateur, especially the amateur who is unfamiliar with the peculiar problems of the industry in question.

In discussion, Mr. CHARLES W. GOODALE of the Anaconda Copper Mining Co. criticised the central employment bureau advocated by the author, and pointed out the destruction of discipline through the process of "hiring and firing." With reference to the "rustling card" system, he stated that of 53,000 cards issued by his company only 650 had been refused.

The History and Legal Phases of the Smoke Problem, presented by LIGON JOHNSON, traces the early history of the smelter-fume problem and the development of the more acute controversies in recent years. The early prejudice engendered by the practice of heap roasting is considered responsible for much of the modern antagonistic attitude of the farmer toward the smelter. The institution of suits by the farmers necessitated elaborate scientific investigations by the smelters to determine the extent and magnitude of damage by smoke and fume. This resulted in securing information that was of value, not only to the smelter but also to the farmer, from the point of view of scientific farming. This has resulted in a friendlier relation between farmer and smelter. The final trouble which still needs to be removed is the idea of the farmer that visible fume is dangerous, and that the gases must be entirely cleared of solids. This is a psychological matter, which will require education to rid the farmer of his belief.

Discussion by P. J. O'GARA, technical director of smoke investigations for the Guggenheim interests, brought out the fact that efforts to obtain visible clearance of the smoke would be futile, since the solids are mainly harmless. The problem can be solved by clearing solids only for recovery of valuable material, and keeping sulphur dioxide below the critical concentration when the humidity is over 70 and the temperature over 40. This can be done even if it requires the temporary shutdown of roasters. It is better to install high chimneys, as at Tacoma, or gas absorbers. Farming experiments show that the lowest gas concentrations more than double the leguminous produce on alkali lands, freeing potash and phosphorus and lessening the soluble alkali.

ALBERT H. FAY of the U. S. Bureau of Mines described the preparedness census of mining engineers, metallurgists and chemists taken by the bureau in co-operation with the American Institute of Mining Engineers and the American Chemical Society. The bureau has a complete list of technically trained men who have been mobilized by the draft, and is in daily conference with the War Department in attempts to transfer these to technical service where they will be of greatest value to the Government.

MR. ALFRED WILSON of the Canadian Department of Mines urged upon this country the conservation of sulphur supplies. At present the Canadian consumption is 300 lb. per ton of sulphite pulp, whereas American is only 250. By educating competent burners, we may save a considerable quantity of sulphur. Further assistance can be rendered by burning pyrite scientifically and reducing the consumption of print paper.

Decrease in White Lead Output in 1916

The United States Geological Survey has completed the statistics of white lead production in 1916. The output of dry white lead was 32,938 short tons worth $4,714,343 as compared to 33,907 tons worth $3,513,856 in 1915. The production of white lead, which was ground in oil, was 96,041 tons worth $16,560,137 as against 122,194 tons worth $15,879,835 in the previous year. The total output of white lead thus showed a loss of 27,122 tons or over 17 per cent in quantity, but a gain of $1,880,789 or nearly 10 per cent in value. The annual report of one of the largest white lead producers says:

"The tonnage of white lead sold was the lowest in many years, due in part perhaps to the activity of competitors but chiefly to the checking of consumption by the high prices not only of white lead but of linseed oil and everything entering into the cost of painting, including wages."

Pittsburgh Meeting of the American Electrochemical Society

The thirty-second general meeting of the American Electrochemical Society held at Pittsburgh, Oct. 3 to 6 inclusive, was marked by the same interest and enthusiasm which is usually in evidence at the sessions of this organization. With a registration of over 325 members and guests the meetings were well attended. The program contained too many excellent papers to afford time for as much discussion as would have been profitable. On the other hand a large number and variety of inspection trips arranged by the local committee gave an opportunity for social and professional intercourse and enabled the visitor to get a comprehensive idea of Pittsburgh's varied industries. The visiting ladies were entertained at receptions, luncheons and dances, one of the features being an invitation luncheon at the Heinz plant, where the famous 57 varieties are made.

Members who were fortunate enough to be present on the first day were guests at the Oakmont Country Club, where golf was the order of the afternoon. In the evening an informal dinner was served at the club, which was attended by 100 members and ladies. Following this the Board of Directors held its regular meetings at which important business was transacted.

Meeting of the Board of Directors

It was voted to subscribe for $2,000 worth of the new issue of Liberty Bonds. The Society also made its customary appropriation of $50 to the International Committee on Physical and Chemical Constants, inasmuch as word was received that the Committee's volume will be issued this year in spite of the war. Dr. C. A. Doremus was appointed to serve with Jos. Bijur as the Society's representative on the War Committee of Technical Societies. While no definite decision was reached regarding the place of the next meeting it was the sentiment of the Board that a meeting in the South next spring would be timely and appropriate. No invitations have been received from this section and definite decision is deferred until a later date. The proposition of meeting at Cleveland was not acted upon at this time in view of the proposed Southern meeting.

Thursday Meeting

The opening session was presided over by President C. G. Fink, who introduced Dr. John A. Brashear of Pittsburgh, who gave an address of welcome. Dr. Brashear painted a panorama of Pittsburgh's scientific and engineering progress as he had personally observed it during more than half a century. He recalled his early association with many famous scientists and engineers, such as Langley and Westinghouse, and related many interesting anecdotes of the struggles and successes of these men.

Mr. Lawrence Addicks and Prof. J. W. Richards, who are the Society's representatives on the Naval Consulting Board, briefly reviewed the work of that organization. Mr. Addicks stated that real progress was being made in the submarine problem, and that there have been positive advances in the protection of merchant ships. Professor Richards announced that the Secretary of the Navy had decided to commission a few graduate electrical engineers as engineer officers in the Navy. These men must be between the ages of twenty-five and thirty-five and the salary will be about $2,300 per annum.

Electrochemical Industries at Shawinigan

The first Thursday paper was presented by **H. E. Randall,** electrochemical engineer of the Shawinigan Water & Power Company, Montreal, describing the development of electrochemical industries at Shawinigan, in the Province of Quebec, Canada, in the St. Maurice Valley, and its availability for further electrochemical plants. He pointed out that at present 511,000 hp. is installed, of which 100,600 hp. is available for immediate use. There is also 580,000 hp. as yet undeveloped which would also be available for electrochemical industries. The principal plants there at present belong to the following companies: Northern Aluminum Company (formerly Pittsburgh Reduction Company), Canada Carbide Company, Shawinigan Electro-Metals Company (magnesium), Canadian Electrode Company (carbon electrodes), Canadian Electro Products Company (acetic acid and acetone), Presto-O-Lite Company (acetylene), Fraser, Brace & Co. (experimental electric furnace work), Canadian Aloxite Company (subsidiary of Carborundum Company).

The author points out that with its low power costs, cheap labor and advantageous export rates it offers a strategic location for serving the European market. At the moment it is one of the few localities in Canada where power in quantity can be obtained quickly and cheaply, and where the necessary labor for plant operation can be obtained without excessive importation. With these present advantages and future possibilities the author thinks it almost certain that Shawinigan will continue to be the electrochemical center of the Dominion of Canada.

Substation Problem of the Electrochemical Plant

In a paper on this subject **J. L. McK. Yardley,** general engineer of the Westinghouse Electric & Manufacturing Company, discussed the relations between the electrical apparatus conditions and the electrochemical conditions; that is, between the factors conditioning efficiency or inefficiency of the electrical installation and the factors imposed by the nature of the electrochemical cells and their arrangement into plant units. The principal conditions which determine the substation layout and the nature of its equipment are given by the author as follows:

(1) The nature and magnitude of the process; that is, the amount of current required per unit cell, tank or pot room, the voltage range, the length of time; also the number of units and the ground space available.

(2) The nature of the power supply, particularly whether the voltage is high or moderate and whether it is practically constant or subject to variations.

(3) The inherent characteristics and costs of available apparatus.

Owing to the intense activity in all the electrochemical industries, such as zinc, copper, aluminium, chlorine and caustic soda, etc., during the past three years, a great variety of new propositions has come under consideration. In most cases it has been found necessary to give full consideration to each condition. An interesting extract from the paper follows:

"Such mistakes and failures as have occurred have only tended to show that in the future there should be still greater co-operation between those whose efforts are able to bring about still greater success. Let us make as sure as we desire of the credentials of the man who wishes to co-operate with us, and then let us co-operate, without stint.

"To take a very simple illustration of the sort of problem to be met, let us assume one desires to produce 20,000 lb. (9000 kg.) of caustic soda per day and has found that a total of approximately 252 electrolytic cells of a certain size are required. It is very doubtful that there are any good reasons from the process point of view why these cells should be arranged in three groups of approximately 84 in series in preference to four groups of approximately 63 in series; whereas, from the apparatus point of view there are good reasons in favor of the latter arrangement. Its requirements fall within the voltage range of apparatus which through years of use has become standardized the country over.

"The manufacturers of electrical apparatus are wide awake to the rapid growth in the electrochemical industries, and they are keen to be leaders in that growth by adapting and applying their apparatus to its requirements in the most economical way, and by anticipating its future wants in new designs. However, it seems just as logical that the others who are interested in this development and want to make it an economical one, *viz.*, the inventors and manufacturers of cells, pots or furnaces and those who arrange them, assemble them, build them into a complete plant, and operate them—should work with equal or even greater zeal for a size and arrangement having requirements which, as nearly as possible, can be met by already standardized electrical apparatus. When one considers the relative costs of the electrical apparatus installation and the cell or furnace room installation, it is quite obvious that this should be so."

Electric Furnaces in the Iron and Steel Industry

The paper by **Robert Turnbull**, electric furnace engineer of Welland, Ont., Canada, was an interesting discussion of **Electric Pig Iron in War Times.** It is reproduced here in full.

* * * *

The abnormal high prices which are at present being paid for iron and steel products, and which have been ruling for the last eighteen months, have seemingly failed to stimulate or encourage the manufacture of pig iron from ore in the electric furnace. Although from $50 to $80 per ton is now being paid for the different grades of pig iron, no progress has been made in the United States or Canada in the production of electric pig iron from ore, and it may safely be said that outside of Sweden and Norway the production of pig iron from ore in the electric furnace is practically *nil*. That pig iron could be made from ore in the electric furnace under present conditions, and at the same time yield a handsome profit, there is not the slightest doubt, but there are many difficulties in the way of the prospective manufacturer and one of the most serious is the shortage of power.

In the early part of 1906, when the smelting of pig iron in the electric furnace was undertaken by the Canadian Government, the report issued some time afterwards claimed that the results of the experiments had proved that 4 tons of pig iron could be produced per horsepower-year; in other words, this amount of iron could be produced with an expenditure of about 1650 kw.-hr., whereas the present Swedish practice, where large furnaces are used, shows that from 2500 to 3000 kw.-hr. is required to produce 1 gross ton of gray iron.

A few years ago the writer made some experiments with a single-phase furnace using about 650 kw., the ore used being a hematite containing from 50 to 52 per cent metallic iron. This furnace was operated for several weeks and the expenditure of energy per gross ton of pig iron produced was 2300 to 2400 kw.-hr. It will therefore readily be seen that to produce any considerable quantity of iron in the electric furnace large amounts of power will be necessary, and this, coupled with the fact that such an enterprise could only be operated under existing conditions, which are liable to change at any moment, has no doubt deterred investors from risking the capital necessary for such an undertaking.

The writer's own experience has not gone to show that any advantage has been gained either by lowering the expenditure of power or decreasing the gross cost of the product by the use of the shaft furnace, such as is used in Sweden, for unless the gases are utilized the shaft furnace becomes a complicated, expensive and unnecessary piece of apparatus. A well-designed ordinary electric smelting furnace with partial roof and automatic charging from overhead hoppers will produce a cheaper pig than the shaft furnace, and the first cost of plant would be considerably less.

With the war, however, a new industry has been created for the electric furnace, which owing to its practically low initial cost in plant and low power consumption, bids fair to become very popular, and that is the production of pig iron from shell turnings and shell scrap.

As the specifications for steel to be used in the manufacture of shells call for low phosphorus and sulphur, it is possible in the electric furnace to produce a low phosphorus pig iron from such scrap at a figure which, given the present selling price of low phosphorus pig iron, yields a handsome profit, while very little refining is necessary. Any type of steel furnace can be used for this process, and it is not even necessary to have a furnace of the tilting type when little refining has to be done, as by special manipulation of the slag in the furnace, a certain amount of phosphorus can be removed, and sulphur is always to some extent eliminated by the basic slag employed.

The possibility of this process was first brought to the writer's attention in the fall of 1916, and experiments were immediately undertaken in a small furnace at Orillia, Ontario. These experiments having proved the process to be a feasible one, a new single-phase furnace was built and has been in successful operation since January of the present year. From 6 to 7 tons of low phosphorus pig iron is being produced per twenty-four hours, the amount of power used on the furnace being about 250 kw.

Furnaces for this work have since been installed at St. Catharines, and Collingwood, Ontario, also at Shawinigan Falls, Quebec, and a number of furnaces are now operating in the United States.

At St. Catharines the furnace is of 6-ton capacity, three-phase operated by Packard transformers of 1200 kw., but only 700 kw. is being used at the present time,

owing to the shortage of power. The daily output is around 20 tons. It is estimated that the production will attain 35 gross tons with the full power of 1200 kw. The operation is in many respects similar to the making of steel in the electric furnace, the refining process for the elimination of phosphorus being somewhat different. The charge consists of shell turnings, the necessary carbon base, which may be charcoal, coke or coal, ferrosilicon and lime. Manganese is not added, as care is taken in the process to conserve the manganese already contained in the turnings. The furnace is of the fixed type, with a carbon bottom and silica brick lining; there are two charging doors and one tap hole, similar to what is used in open-hearth furnaces. The furnace is controlled by automatic regulators, which eliminate to a great extent manual labor on the furnace, besides giving a much steadier load than is possible by hand control. The product is cast in sand, the pig beds being placed about 30 ft. from the furnace. In our Orillia plant the iron is cast into iron molds, which make a better looking pig than sand casting. The return in iron as compared with the scrap charged is about 95 per cent, and as about 5 per cent is added to the iron in the form of carbon and silicon, the total loss is about 10 per cent of scrap charged. The pig produced is very tough and the analysis is fairly uniform, as can be judged by the following table of consecutive heats:

Heat No.	Silicon	Sulphur	Phosphorus
237	1.45	0.025	0.025
238	1.83	0.029	0.031
239	2.82	0.030	0.033
240	2.11	0.029	0.027
241	1.88	0.025	0.027
242	2.49	0.027	0.027
243	1.21	0.035	0.040
244	2.35	0.030	0.030
245	1.25	0.029	0.031
246	1.55	0.027	0.027
247	1.59	0.028	0.031
248	1.50	0.025	0.029
249	2.02	0.029	0.032
250	1.50	0.032	0.038
251	1.41	0.029	0.033
252	1.50	0.025	0.023
253	2.20	0.025	0.027
254	1.50	0.027	0.030

The carbon is very rarely over 3 per cent; from this point onward any extra carbon added is very destructive to the lining and roof of the furnace. A roof will last from 150 to 200 heats; the roof conditions are being gradually improved and 300 heats may yet be realized for one roof.

The process is not a new one, as attempts were made several years ago to make pig iron from scrap steel, but the cost was found to be prohibitive. The writer also made some experiments in operating the pig-iron furnace for ore, before mentioned, by mixing 50 per cent each of scrap and ore in the charge. The result was an increased production from about 6 tons on ore alone to 11 tons with the mixture. The same amount of power was used in both cases.

In passing, it might be said that some of the blast furnaces in the States are now mixing considerable quantities of steel turnings with the ore, in order to increase their output.

Whether this process will be feasible after the war and when normal conditions are again with us is not a settled point. The cost of production is at present high, and would be prohibitive under normal conditions. It must be remembered, however, that costs to-day are possibly 50 per cent higher than they were three years ago, and it is the writer's conviction that provided future experiments find a means of eliminating phosphorus from the iron without removing the slag, the process can be profitably operated in normal times, at least in Canada, where low phosphorus pig iron is always a dollar or two higher than in the United States.

In conclusion, although a little foreign to this paper, the writer would like to call the attention of all those interested in steel furnaces to the roof coolers, which are placed around the electrodes in order to keep the bricks at that point as cool as possible. Recent practice at St. Catharines has shown that the life of the roof can be prolonged materially by correct application of these roof coolers, especially the ring of bricks around the electrodes. These coolers should be made to the exact form of the roof, and should rest on the bricks which form the ring around the electrode, and not on any packing between these bricks and the cooler. They should not be flanged, but cast to a special form, so that the cooling water will be at an equal distance from all outside surfaces. The writer will be glad to give any further particulars to members who may be interested.

A paper by **Russell E. Lowe** of the Fitz Gerald Laboratories, Inc., Niagara Falls, N. Y., described a method for the commercial **analysis of ferrosilicon.** Rapid and accurate methods for the determination of sulphur, phosphorus, manganese, iron, aluminium and silicon. The usual elements found in 50 per cent ferrosilicon were given.

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Frank Thornton, Jr., described experiments on an **electric resistance furnace** with various resistors placed inside the furnace, either on the hearth of the furnace or on a shelf around the walls. The furnace was designed for heating steel commercially to forging temperatures. It was pointed out that such a furnace would have many other applications, such as heat treating, melting, firing ceramics, etc. Many difficulties were encountered in using granular resistor beds, and it was decided to try silica carbide blocks or slabs for the resistance material. The results were satisfactory and the furnace was operated successfully up to 1200 deg. C. for hardening tools and dies and for firing porcelain.

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The **Electric Furnace in the Norwegian Iron Industry** was described in an interesting paper by **Haakon Styri** of the Hussey-Binns Steel Company, Charleroi, Pa. The author reviews the development of the Norwegian iron industry and follows with an account of the introduction of electric steel furnaces and electric pig iron furnaces. Most of the furnaces in Norway are of the Rennerfelt type, although the Heroult furnace is being seriously considered by a new, larger concern.

In late years, in Norway, there has been a great desire to get iron and steel works which could produce shapes, plates and other commercial steel in order that the country might be more independent of imports. During the present war this need has been bitterly felt, as it is extremely difficult to get commercial steel from the belligerent countries, which formerly furnished it all. Many private corporations have investigated the possibilities of starting a modern steel plant, and much capital was expected to back the plans if they could be satisfactorily worked out, but the present soaring

prices of all new construction has put a stop to further important development. Another reason for little progress in the plans was the difficulty in working the different local interests together into a national interest, and the Government has not been favorable to electric furnaces.

The author states that conditions do not look promising for the production of steel on a larger scale in Norway. England and Norway have no duty on imported iron. He says:

"The prospects can, of course, change. It is possible that concentrate can be used direct in an electric reduction furnace, at least where little attempt is made to utilize carbon monoxide in the reduction of the ore, by using the gas instead for heating pig-iron mixers, where the main decarbonizing could be done, for melting of scrap, and for heating of by-product coke ovens. The gas from the coke ovens could be sold to the city. The steel product could be finished in an induction or arc furnace.

"Another method is now on trial, basing the operation on the direct use of low-grade ore by the Edwin-Westberg-Gröndal process. Interested Norwegians and Swedes have secured $150,000 for the purpose of testing the method on a commercial scale. The low-grade ore is crushed according to the structure, and is treated in the furnace with reducing gases which are heated outside in a high-tension arc furnace similar to the one used for the manufacture of saltpeter. The reduced iron is afterward separated magnetically from the rock, and the iron powder melted in an electric furnace. The successful iron and steel works in Norway have based their production on high quality of product. The manufacture of structural steel is not, and probably will not be tried in the near future, on account of the competition from foreign countries. What Norwegians want and look forward to is the time when the country can again furnish iron and steel which comes up to the old standard of Norway iron."

Electric Furnace for Brass Melting

T. F. Baily, president of the Electric Furnace Company of America, Cleveland, Ohio, described a resistance type furnace for melting brass and bronze.

The furnace is of the non-crucible type and operates on the true resistance principle. A general description of the furnace is as follows:

In a cylindrical shell, supported by the usual trunnions and brackets for tilting, is constructed suitable walls and roof forming the furnace chamber. The bottom of this chamber is so shaped as to make a bowl-shaped hearth for containing the metal when melted.

The resistance element is contained in a circular trough made of a refractory material similar to carborundum fire sand. In this refractory trough the resistance material, composed of broken carbon, is placed, forming contact with the electrodes which are placed diametrically opposite each other with their ends protruding into the circular trough.

The control of the current, and hence of the furnace temperature and melting capacity, is by means of suitable voltage taps brought out from the secondary of a special transformer supplied with each furnace.

Running tests were given of melting bronze and brass, with mechanical tests of the cartridge brass produced and numerous analyses showing the uniformity of the metal at the beginning and end of the cast. The electrical power required shows favorable comparison of melting costs with crucible or open-flame melting furnaces, the average being 450 kw.-hr. per short ton of bearing bronze (495 per metric ton), and 311 kw.-hr. per short ton of cartridge brass (342 per metric ton).

Pure Alloys for Magnetic Purposes

A paper by **Trygve D. Yensen** of the University of Illinois described an electrolytic plant for producing pure iron and discussed the reasons why pure iron and iron containing elements which do not separate its crystals from each other have great magnetic permeability and low hysteresis losses. Ordinary and vacuum electric furnaces for making the alloys at temperatures up to 1800 deg. C. were also described; also annealing furnaces for heat treatment of the alloys produced.

Influence of Temperature on Properties of Steels

A paper by **Edward D. Campbell,** emeritus professor at the University of Michigan, described the influence of temperature on the electrical resistivity and thermo-electromotive potential of steels. It will be published in full in our next issue.

Calorized Iron

Prof. **O. L. Kowalke** of the University of Wisconsin compared the thermoelectromotive force of couples of "calorized" iron-constantan with that of "uncalorized" iron-constantan. A sample of "calorized" iron wire from the General Electric Company gave the same thermoelectric potentials as "uncalorized" iron up to 1000 deg. C. on repeated calibration. A sample from the Brown Instrument Company gave slightly different potentials until after it had been heat treated at 800 deg. C., after which it gave similar results to the other "calorized" wire. The author concludes that a heavy wire, lightly calorized, gives as constant results as uncalorized iron, and has a much longer life.

* * * *

After a complimentary luncheon at the William Penn Hotel excursions were made to various industrial plants in the Pittsburgh district. A large party went to the American Zinc & Chemical Company at Langeloth, where they had an opportunity to observe the roasting and smelting of zinc ore and the manufacture of sulphuric and nitric acids, zinc sulphate and zinc dust.

Other parties visited the Research Laboratory of the American Sheet & Tin Plate Company, the Mellon Institute of Industrial Research, the University of Pittsburgh, the Carnegie Technical School and the Carnegie Museum.

Production of Electricity by Steam Power

On account of the prime importance of the power question in electrochemical and electrometallurgical industries, the Society invited Mr. ALEX. DOW, President of the Detroit Edison Company, to speak on the present status of the production of electric power from steam. Mr. Dow gave a masterly address of particular interest to the Society because he considered his subject from the viewpoint of electrochemical needs. From a stenographic report of his address we make the following excerpt:

You are more interested in power delivered and avail-

able for your work than you are in the question of generating or producing power at the terminals of a dynamo-electric machine; therefore, it will be necessary for me to talk discursively, to go into questions of distribution and transmission, and to some extent into the utilization of power in order to get before you the ideas which I think you expect me to present, namely, the present status of the production of electric power from steam, as I understand that status to be.

Let me make the point again, that delivered power and generated power are two different factors. Generated power is the actual power produced at the terminals of your machine; the output is the amount of power delivered into your trunk lines, or turned out from your station into the trunk lines. The difference between the two represents uses in the power house, lighting, heating, excitation, the operation of auxiliaries, and all the minor losses incurred in any power-plant output. The net power output is what the great majority of central-station men are concerned with.

In a close net-work, such as serving one big mill owning its own power-plant, the difference between the actual delivery to the points of use may be eight or ten per cent. In a complex works, covering a large area, and delivering power in different forms, the order of difference is more likely to be 20 per cent and upwards. That is to say, if the meters of a large central-statoin net-work account for 80 per cent of the current generated at the power-house, or of the output from the power-house, they are doing very well. The distribution efficiency is first-class.

Fuel cost is the one figure on which comparisons can be made, and fuel cost must be expressed in heat units to meet the comparison. These show year in and year out an approximation of 20,000 heat units per kw.-hr., with periods below and periods above it. In no case do they exceed the 20,000 figure, and when they get below it it is at very favorable seasons of the year. From the adaptation of the stoker and the furnace to the fuel it has been carried to the limit of our present knowledge.

Heat Balance—You should not throw heat overboard beyond what you can save. It is essential to get as much power out of the steam you make as is possible.

You will remember that something like eight-tenths of the heat units are hopelessly lost in the condensing system. Any heat process, therefore, which uses electric heat has an initial handicap if the electric heat is produced by combustion.

By our present methods you will never get higher efficiencies than that corresponding to 100 per cent efficient use of the electricity. You can approximate that, getting into the high nineties, but the electricity will represent only 81 or 82 per cent of the heat in the fuel. Therefore, in electrical heating, you use it because of electricity's other merits. And its large use proves that wise men are willing to pay for those other merits, and that fuel economy is not the only thing to consider in industry.

Put me down as saying that where electric heating is used and the origin of the electricity is in fuel, you are absolutely applying that heat wastefully, considered as an application of heat, and the wastefulness is hopeless. The loss overboard in the condensing water is the big thing. All other losses, radiant losses from boilers and engines are minor in comparison.

Cost of Power

The total cost is the fixed cost plus operating. It makes a division into standing and running cost, the standing cost being the station rate for service, and the running cost being the added cost due to service.

Let me say this: The fixed element is so very large that at poor load-factors it is controlling. That load-factor must come back to you time and time again. With some of you the load-factor is high; with others it is inclined to be low. The electrochemical load-factor is of the order of 90 per cent of what would be obtained if the maximum hours, that is 8760 hours, were obtained during the year.

You gentlemen are in the habit of telling us you have 100 per cent load-factor. Ninety per cent is going strong, and the eighties are more frequent. On the other hand a mixed service is doing well if it shows 40 per cent. Any central-station with the load-factor above 40 per cent is doing well, indeed. Below that is common.

The cost of money, plus the investment, plus the taxes, means that the central station must figure on a return never less than 12 per cent, and sometimes exceeding 15 per cent. So your first figure, based on the central-station method, is to figure 12 to 15 per cent as a figure on an investment per kilowatt, which was between $50,000 and $60,000, and which now is between 90 and 110 per cent.

Now, assume we have the problem put to me by some of your members, that you want a power-plant, the object being low total cost of power, and that you have some choice of location. The first thing to consider is how the location may affect the power-plant; and that leads into those engineering problems I wish to put to you.

With electrochemical industries, of course, you must consider your raw material and your markets. You must have good shipping points, you must have fairly good labor conditions, etc. These conditions would have a large influence in determining the location; but if you leave us free to transmit the power from a satisfactory location for the power-plant, if that be in the premises of this discussion, we can forget these considerations for the present.

Take item No. 1—the fuel cost. If the load-factor is of the order of 90 per cent, fuel cost will be the most important thing to consider. In connection with fuel cost you must consider the certainty of the supply—that it will not be interrupted.

Then you must have plenty of water. The quantity of water used by a big steam plant is something you do not conceive. A plant of 100,000 kw., operating at 50 per cent, will require to pass through its condensers approximately the same amount of water as will be used by a mixed residential, industrial and commercial community having a population of 750,000 people. In other words, my power plants take up from the river, heat to 10 or 15 deg. and reject to the river again, more water than is pumped for the whole community. Therefore, the water-supply is the next thing to consider after a good supply of fuel. You must locate on navigable rivers or streams, or on the Great Lakes. Cooling towers are devices you must forswear if you are working for maximum efficiency. One of the most appropriate places for a cooling tower is in the dry Southwest where the rapid evaporation of an exceed-

ingly dry atmosphere cools the water sufficiently and the night chill gives you a fair start the next morning. To locate a big plant on a country duck pond is foolishness.

The next consideration of importance is the labor condition. Power-house labor is changing its character very much. There was a time when the power-house got incipient geniuses; that was a mistake. But the day has come for brains, and they are being secured. To-day the power-house employees expect good pay and good environment.

The engineer now wants his shower when he goes off watch, and sometimes he calls his relief and takes a shower while his turn is on. You must supply first-class working conditions. These men expect their outside, off-work, conditions to be such as they can pleasantly live in when they are off watch, where the older men can bring up their families and the younger members can hope to persuade "the only girl" to come.

If you locate on a place where people consider the outer appearance you must think of an architect. I can think of three power-houses where the outside appearance is a credit to the public-spirit of the board of directors, while the inside is a libel upon the architect. Foundations will run to $5 per kilowatt when you locate in a marsh with rock 100 or 150 ft. down, and you must pile or go down to that rock; or if you locate on the Ohio River where you have 70 ft. of rise and fall, there you have a serious problem.

These things balance up. Low-fuel cost can be offset by good water-supply. It is better to go a little away from the coal to get better freight, etc. The big thing is whether you will locate close to your load or transmit.

Disadvantages of Transmission

Now, transmission is expensive. It has a very definite measure as to its capacity and a high figure as to its unit cost.

The right-of-way of your transmission line is another item of high cost. The line-loss may be a high cost.

Again, transmissions are not reliable. I have been considering that and lightning troubles. This was a year notable for lightning, when lightning was painful and frequent and free. We have such things as lightning arresters and they take care of secondary surges; but when you get a real direct stroke of lightning you go around with a shovel and clean up. Again, porcelain insulators are supposed to adjust themselves to all conditions of heat and cold while placed *inside* of a rigid cap, and are expected to stay put. Well, there are limits to human beings and there are limits to the elements which constitute these porcelains. Then you will find that lines which behaved splendidly for seven or eight years, after that time behave miserably.

So, another thing you must balance is unreliability. Then do not forget cyclones.

If you are generating by steam power it is probable that your big plant will be *per se* more reliable than any plant you can construct on your own premises; but the intervening link may change conditions. You must consider whether you want your process to hinge upon the unavoidable conditions which I pointed out, with the transmission line losses assumed at 15 per cent. That is high. You may spend money and cut it down. The distribution I spoke of is of the order of 20 per cent total.

I have here some figures in which the transmission loss is 18.7 per cent; of that 5.6 per cent is lost in the line, 3 per cent is lost in the substation transformers; loss in the synchronizer is one-tenth of 1 per cent; the current loss in changing from alternating to direct is four-tenths per cent, storage battery is of the same order; and then there are distribution losses, line transformers, meter shunts, and slow meters, etc.

Now, as to the question of location versus transmission, it turns not on the question of reliability or unreliability, as duplicate lines could reach that; it turns on your own problems of materials and markets. The answer is, if the power cost controls, you must get to your power-plant or bring the plant to you; otherwise you must consider the cost of materials and markets and then make the best adjustment you can between reliability, the location and your own conditions. It would be possible I think, I have said so to some of your members, to locate a considerable number of centers where a given adjustment could be made between all these conditions, and then the conditions of design would have to be predicated very closely.

If you come to generation only, 19,000 heat-units is entirely practicable. The missing figures which I had to show you would have made clear to you that the other operating costs are of the order of one-tenth per cent. You can figure the cost of your 19,000 heat-units.

As to gas fuel: Yes, there is a chance for betterment in gas fuel. You can control your mixture; lose no carbon in your ashes and have higher transmission values. But gas as a commercial proposition in almost all of the United States is entirely dependent for its cost upon the by-product market; and that as you know is anybody's guess. In the meantime gas-producers as an addition to boilers cost too much. No combination in present or recent conditions can be made that will allow gas fuel to be used in steam boilers. The gas-engine has its place. At present the large steam-turbine has it beaten. With free gas or natural gas the gas engine has its merits.

Pulverized coal must be considered in any new design. It is first-class now in locomotives because of the impossibility of firing by hand the present big machines. There is a better control of the air mixture; you cut off your fuel and that is the end of it.

The whole question of pulverized coal turns upon the point that it may make useful coal which with stokers of the present time are not useful. That may tend to reduce total power-cost. The big point is to adapt the plant design to the fuel you are going to use.

What I have told you of design for making steam efficiently is based on man-sized experiments in which were determined the upper and the lower limits. The rule of finding how far you could go before trouble started, and then how far in the reverse direction you could go after the trouble started is the only rule to give you anything proper. But to go in one direction a great way because a little has proven well is bad engineering.

Turbine Troubles

Now, turbine troubles exist of course. Your turbines, most of them, are fine ladies so to speak; treat them right and they will treat you properly; and if you do not they will have hysterics or the mechanical equivalent thereof.

There are few bad turbines. If you take 200 tons of

turbine and place it on a foundation it is well after six months' time to examine that turbine foundation to see if it has not settled. If you examine it you will see that the turbine has been telling you its message for the past six weeks and you have given no heed to it. A well-made piece of machinery, such as a turbine, requires on the part of those having it a little imagination to know what is going on on the inside.

Now, in closing: It is not good to prophesy, but I know some of you expect to hear from me whether I anticipate any great change in the art. I do not, just now. All I can say is: there is not in sight, any great change. Unless we can find the materials to take us into higher temperatures, we need not expect much change. Many of the losses are commercial which cannot be saved profitably. The losses necessary to give you the necessary draft; and the big losses of heat thrown overboard—they seem to be inherent in steam.

I have not told you all I know, but I have told you all I can crowd into a reasonable time, with a bad start.

Mr. Addicks opened the discussion by saying that if the electrochemist could give Mr. Dow a 100 per cent storage battery we could improve conditions greatly. He believed the day was passed when we will buy power from the central station and that the building of a steam plant for the special use of the electrochemist is the next idea in view. As a result of investigation he had reached the conclusion that if coal could be secured at $1.25 per ton at the mouth of the mine, power could be generated for $15 per horsepower year, excluding interest on the investment. This approximates the rates at Niagara Falls, but there is still hope that waterpower will show better costs than the steam plant is now doing.

Mr. **F. A. Lidbury** then spoke as follows:

In an address and discussion about eighteen months ago in Washington, Mr. Addicks took the view that we had better stop speaking of the waterpowers that existed in this country and turn our attention to steam because, as he then pointed out, it was going to be as economical to generate steam as to use waterpower. That view was not uncontradicted at the time, and might not have resulted in great attention being given at this time to this particular question by this society, had it not coincided with the shortage of power for electrochemical purposes which was then serious and has since become a national menace. Taking the figures Mr. Addicks gave at their face value, a number of us decided to look into the matter and see what could be done, for the situation seemed to be one which should not permit any stone to be left unturned.

In this particular matter we found the remarkable spirit of co-operation of the Detroit Edison Company, which has been so well exhibited in what Mr. Dow has said to-night. The matter was not taken up in the first place by Mr. Dow, but with Mr. Crosby; and through Mr. Crosby Mr. Dow got interested.

The result of the detailed conference we had with Mr. Dow at Niagara Falls was, I am sorry to say, that most of us lost interest in steam power under present conditions.

It seems to be a matter of general conclusion, that if we could revert to pre-war conditions, the thing would be worthy not only of general consideration but of serious detailed consideration. However, with things as they are, with prices of apparatus as they are, and particularly the price of coal as it is and as it will remain for some time, it would be impossible to go into it on any basis that could be considered commercial.

In other words, we jumped at the idea of steam power under improved modern conditions. As soon as we found what it meant, we jumped back as rapidly as we could.

Now, I always like to check things of that kind by facts, and the facts in recent months indicate that there is no tendency on the part of the electrochemical industry to go to something else. What we see to-day is the continuation of the process we have been watching for a number of years in an increasing degree, and will continue as far as we can see at present; and that is the expatriation of industries which exist primarily for the need of this country.

There is a national aspect to this matter. In the broad point of view it is very doubtful to what extent this country should permit the migration of industries which are as fundamental to its life as any others that can be mentioned. We have got to let these industries go, or we have got to treat the matter politically and decide they must be kept in the country by hook or by crook, at whatever price steam power might permit them to produce their goods, and impose a tariff sufficiently heavy as to be prohibitive. Or, the most sensible course, *to permit and to insist upon and to enforce the thorough-going utilization of our natural water power resources, which could solve this whole question inside of two or three years.* (Applause.)

We have been talking of improvement in this matter for four or five years, or even longer. We have had a respectful hearing in our own society. Outside we have been treated as cranks or as malefactors. The result is this country is faced with an alarming condition with respect to its productive power for a tremendous number of articles which are fundamental necessities for warfare.

Nobody realizes at this time the extent and the seriousness of this matter. Nobody realizes it because there does not exist even to-day in the Department in Washington any accurate knowledge of the quantities of materials and supplies which will be necessary and the production of which depends upon the electrochemical industries of the country. We will have a demonstration of the policy which this country has developed in regard to waterpower legislation, and the only hope we can express is that when matters do come to a sufficiently clear indication of the mess we are in, we will put ourselves in such a position that the same thing cannot occur again.

Friday Meeting

Reforms in Chemical Terms

On Friday the technical session was opened with a paper by Dr. **Carl Hering** of Philadelphia, in which he suggested several important changes in chemical terms. He has written several previous papers on this subject during the past two years, which have appeared in the columns of this journal. He summarized his work as follows:

"A more precise distinction should be made between different kinds of bonds. The term valence should be more strictly defined; negative and zero valences should be included. The proposed practical unit for measuring

electrons should be used. The ionized state should be considered as differing in kind from either the free or the combined state. Reduction should include all and only cases of reductions in valence, and oxidation all and only cases of an increase of valence, hence the new term adduction. The significance of the gaining and losing of electrons should be more clearly understood; the sign of electrode potentials is then more easily understood. As sometimes stated, Faraday's law is not a universal one, and it is a corollary of a more basic one."

Radium and Chlorine in Warfare

Messrs. **Charles H. Viol** and **Glenn G. Kammer,** research chemists of the Standard Chemical Company, Pittsburgh, Pa., describes briefly the sources and extraction of radium and discussed its use in warfare. The principal uses are in therapy and as luminous paint for many purposes. This luminous paint has been found very useful in warfare. The authors stated that it consists principally of crystalline hexagonal zinc sulphide with 0.215 mg. of radium per gram of sulphide.

The use of chlorine in war was described by **Wm. D. Marshall,** who took up its use in sterilizing drinking water and in making hydrochlorite solution for field use.

In discussion of this paper Mr. **Schulte** presented a brief description of a simple apparatus for sterilizing water with chlorine. The apparatus consisted of two carbon electrodes between which was pressed filter paper saturated with sodium chloride. The apparatus was designed to be used in connection with small dry cells. To illustrate the efficiency of the apparatus Mr. Schulte gave a number of examples of effective sterilization of lake water.

Electrochemical Gasoline

An interesting set of experiments was described by **Louis B. Cherry.** The experiments were made to support a theory of the synthetic production of gasoline by electrochemical and electrothermal means. It was thought possible that by uniting in proper proportion and form sufficient methane or hydrogen gas to certain of the heavier hydrocarbons that synthetic gasoline could be produced. Natural gas was suggested as a source of methane. The gas and oil vapors were subjected to a high-voltage oscillatory high-frequency current, in treatment chambers made of 1 in. (2.5 cm.) pipe which had been plugged and reamed, the ends of which were fitted with modified spark plugs which served to lead in the current through a fine No. 30 (0.25 mm.) platinum wire, which wire passed through the center of the pipe from end to end, and which, when connected to the high-frequency coil, subjected the gas and oil vapor, passing through the pipe, to a silent electric discharge, alternating back and forth, between the central electrode and the pipe, and at right angles to the direction of the flow of gas.

This was a very crude equipment, without pyrometers or pressure gages, and was operated at high pressure and high temperature, but it served to demonstrate the feasibility of the process, by converting 42½ deg. Bé. kerosene into 65 deg. Bé. gravity gasoline. This was done at high pressure and temperature, and was operated for several hours before the equipment exploded, completely wrecking the small frame building in which it was located.

A plant was then designed to convert one gallon of oil per minute. The still was of pipe construction, 4 in. (10 cm.) double-extra-heavy pipe, welded flanges, electrically heated, and consumed about 40 kva. of electrical energy at 60 volts, using 60-cycle alternating current.

Electric power was brought in at 110 volts, and by means of an autotransformer, arranged with twenty-five 3-volt taps connected to a switchboard panel equipped with a special rotary switch with twenty-five contact points or clips (see Fig. 2), control of the heat was very sensitive. The oscillatory electrical generating apparatus for this plant consisted of 1-kva., 110 to 25,000-volt step-up transformer, with a variable reactance in the primary, a variable condenser, rotary spark-gap and oscillatory transformer.

The difficulties encountered with operation under high pressure were so great that it was decided to carry on experiments under atmospheric pressure. A larger plant was then built, the chief difficulties being in designing high-frequency apparatus to produce current of several hundred thousand cycles per second, a potential upwards of a hundred thousand volts, current generating capacity of three to five amperes at the above voltage, and to build the equipment so reliable that it could be operated continuously twenty-four hours per day and seven days per week.

The step-up transformer was designed of the closed-core type, 110/220-50,000/100,000 volts, and rated at 30 kva., but with a real capacity of 75 kva.

In the design of the oscillatory transformer it was decided to use a vertical transformer case composed of porcelain 4 ft. (1.2 m.) in height, 14 in. (35 cm.) greatest outside diameter, and with a wall 1 in. (2.5 cm.) thick.

This high-frequency equipment is mounted on a gallery about 8 ft. (2.4 m.) above the main floor, and is capable of the widest range in operation, being capable of producing high-frequency current from 15,000 to about 250,000 volts, and has a capacity of converting into gasoline about 60,000 gallons of oil in one day of twenty-four hours.

Experience with the first plant with its 3-ft. (0.9-m.) treatment chambers proved they were not sufficiently long, so in building this second plant the treatment pipes or chambers were built with a total length of 10 ft. (3 m.). For experimental purposes a seven-barrel still is used, which is fired with natural gas, and the vapor outlet of the still is connected to the treatment chambers.

These pipes are heated by induction, being wound their entire length with double 0 copper cable (9 mm.) electrically insulated with a special fireproof insulating compound, and connected to an autotransformer similar to the one used in the first plant.

On operating this equipment, a 78 per cent conversion was made from kerosene, and as this was not considered ideal, it was again decided to increase the length of the treatment chambers to 34 ft., which should give an efficiency approaching 100 per cent conversion.

In order to successfully put the process into commercial operation it is planned to build treatment chambers adjacent to the crude-oil stills now installed in the various refineries in the country, connect them to the vapor line of the stills, put a perforated gas pipe in the bottom of each still for the admission of natural

gas, and after the first benzine "cut" is made, divert the vapors of the heavier fractions through the treatment chambers, which, when mixed with the natural gas which has been admitted by the perforated pipe, may be converted into a crude benzine similar to that which was first taken from the crude oil.

As stated at first, the density of the product may be changed by varying the frequency of the oscillatory current, but by experiment it has been discovered that the product may be more easily changed in density by varying the temperature of the treatment chambers, and in so doing one would expect that a temperature might be reached which would break down or "crack" the oil vapors with the attendant precipitation of carbon; but so far this trouble has not been experienced, although temperatures have been carried up to 480 deg. C. (about 900 deg. Fahr.). Had this temperature been carried without the presence of the high-frequency current, precipitation of carbon would have been very rapid, and an ill-smelling product consisting largely of the olefines would have been the result.

Apparently the ionizing effect of the heated tubes combines with the effect of the high-frequency current, and produces a resultant effect upon the gases and oil vapors, disorganizing, and at the same time reorganizing their molecular formation, this being done without complete separation of their elements.

It is predicted that the aromatic hydrocarbons, such as benzol and toluol (which are in so great demand at present for the manufacture of dyes and explosives) will be made by some modification of this process.

Some experimenting has been done in this line, with kerosene (without the addition of natural gas), under a pressure of 80 lb. per square inch (5½ atmospheres), and a temperature of the treating chambers of 538 deg. C. (1000 deg. Fahr.), which produced a distillate which seemed to be composed largely of a mixture of benzol and toluol. Complete refining and rectification of these products were not made, but their reaction with different reagents and their ability to dissolve asphaltum indicated a high percentage of these two compounds. Further investigation along this line is contemplated in the near future.

Spectroscopic Determination of Lead

The authors of this paper, **C. W. Hill** and **G. P. Luckey,** described a rapid method of determination of lead in factory samples of copper. A known weight of copper is placed in a slight cavity in a lower positive graphite electrode, and a fixed or rotating carbon negative electrode used above. A grating spectroscope serves to observe the spectrum. The time required to cause the disappearance of the bright lead line in the spectrum, or to cause its enfeeblement to a certain dimness, is measured with a stop-watch. With carefully regulated arc, the times vary regularly with the amount of copper used and with its percentage of lead, *e.g.*, from fourteen seconds with 0.2 g. copper containing 0.004 per cent lead to 277 seconds with 1 g. copper containing 0.038 per cent lead. The results are sufficiently reliable for practical use in the copper refinery.

Mr. **W. R. Mott** stated that those metals which formed beads and did not "wet" the arc or dissolve the carbon to any appreciable extent were most amenable to the method described. These include the following metals given in the order of their boiling points: As, Cd, Zn, Tl, Bi, Sb, Pb, Ag, Sn, Cu and Au. For analytical purposes the better combination would be of those metals having widely separated boiling points. Thus the following combinations would not give complete separation: As and Cd, Bi and Pb, Sn and Cu.

Copper Castings for Electrical Purposes

In a paper on this subject **W. M. Corse** and **G. F. Comstock** of the Titanium Alloy Steel Company, Niagara Falls, reviewed the progress in refining which permitted efficient transmission of electricity with negligible losses due to resistance. They cited early work of Matthiessen and the consequent improvement in conductivity from 50 per cent to 100 per cent. They reviewed Addicks' work on effect of impurities on electrical conductivity of commercial copper and contrasted the possibility of getting copper wire of high conductivity with production of castings of equally good conductivity. For the former it is necessary only to start with pure copper bar. With the latter there are difficulties due to rapid absorption of oxygen and other gases when copper is melted with formation of copper oxide. When the metal freezes, blowholes are formed due to evolution of the gases, and films of copper oxide are formed as an eutectic between the grains of metal. These films and blowholes impair the conductivity of the metal.

In order to make sound and strong castings foundrymen have usually added an impurity, such as zinc, so that strength is obtained at the expense of conductivity. The authors have experimented with silicon as a deoxidizer, finding it superior to zinc. They have made complicated and large sand castings of pure copper having 75 to 85 per cent conductivity as compared with 40 per cent to 50 per cent usually obtained with zinc. Castings are soft and weak, but they hope eventually to get strength without losing the conductivity.

In the discussion Mr. **H. E. Randall** stated that the addition of 0.2 to 0.3 per cent of magnesium aids in the production of copper castings with satisfactory conductivity.

Electrolytic Copper

In a paper on the electrolytic recovery of copper and sulphuric acid from copper mill pickling solutions, **J. L. Jones,** metallurgist of the Westinghouse Electric & Manufacturing Company, described the percipitation of copper from waste copper sulphate pickling solutions by iron scrap, also of neutralizing the excess of acid and evaporating down to copper sulphate crystals (bluestone). He then described an electrolytic plant for extracting the copper in a pure condition and regenerating the acid for re-use. The acid content is run up to 20 per cent and the copper content reduced to about 1 per cent. Some of the copper is deposited directly on steel plates as copper plating, but most of it is collected as cathodes for re-melting.

Electro-Analysis

A new electro-analysis apparatus for non-ferrous alloys, was described by **J. L. Jones** in another paper. It has been in use in the laboratory of the Westinghouse Electric & Manufacturing Company for about two years. One ten-unit and two six-unit machines have been built and are now in use. They are electrically stirred. The electrodes and beakers are fixed and stirring is done by revolving tungsten rods. Each analysis

receives its own current, graded by a rheostat from 0.5 to 6 amperes. A switch and push-button at each beaker enable the amperage and voltage to be determined at any time.

Lithium in Storage Batteries

L. C. Turnock of the Carnegie Institute of Technology, Pittsburgh, Pa., described an investigation made to determine the magnitude of the effect of various additions of lithium hydrate to the potassium hydrate electrolyte of the Edison storage battery. Comparative tests of capacity of Edison storage batteries were made with 0, 10, 20, 30, 40 and 50 grams per liter of lithium hydrate added to the usual 21 per cent caustic pot-ash electrolyte. Test runs showed increased capacity up to 12 per cent with the largest amount of lithium hydrate, in spite of the fact that the addition increased the electrical resistance of the electrolyte 21 per cent.

In reply to a question by Prof. Bancroft as to whether both electrodes or only one was affected, the author stated that while the point had not been definitely determined he was of the opinion that it was the positive electrode.

Corrosion of Fence Wire

The results of a large number of investigations on this subject were described by **Oliver W. Storey** of the C. F. Burgess Laboratories, Madison, Wis. Important conclusions were drawn from the work and are given by the author as follows:

1. It has been definitely established that the durability of old steel fence wire is due to the presence of copper.

2. Manganese does not increase the corrosion of steel, and its absence does not decrease the corrosion.

3. The copper in the early steel and wrought irons came from the copper-bearing ores of the eastern United States and imported ores. The proportion of copper-steel made decreased with the increasing importance of the copper-free Lake Superior ores.

4. Steel fence-wire containing copper is as durable as wrought iron.

5. Present-day steel fence wire usually does not contain copper, and therefore corrodes rapidly.

6. Under ordinary atmospheric conditions zinc corrodes more slowly under conditions favoring rapid corrosion of iron, and *vice versa*, iron corrodes more slowly under conditions favoring rapid corrosion of zinc.

7. The life of fence wire is dependent upon the quality of both the galvanizing and iron or steel base. Since the galvanizing is usually thin, the life of the fence depends principally upon the iron or steel base, which should be highly resistant to corrosion.

Mr. **F. N. Speller** pointed out that each corrosion problem must be treated individually and that a successful method of meeting one condition could not necessarily be applied to another. Thus sheets and pipes of copper-steel show the same resistance as barbed wire so far as external or atmospheric corrosion is concerned, but pipes carrying water will show marked internal corrosion. The difference is ascribed to a variation in the relative quantities of moisture and oxygen present.

Mr. **T. D. Yensen** cautioned against jumping at broad conclusions in interpreting incomplete data on corrosion. He also emphasized the point that the resistance of copper-steel would vary with the conditions, particularly with the variation in the relative quantities of electrolyte (moisture) and depolarizer (oxygen) present.

Mr. **Buck** corroborated Mr. Storey's work and showed numerous samples of barbed fence wire with the analysis of their copper content. It had been his observation that while copper-steel wire would show initial surface rust, the formation tended to slow up and almost stop in from 10 to 15 months, whereas ordinary steel wire would continue to disintegrate. Copper-steel wire seems to form a protective coating that prevents further loss in weight. In reply to a question by Dr. Flint regarding the effect of salt-laden atmosphere or solution on copper-steel, Mr. Buck replied that he had found all steels to disintegrate in brine solution, but that in some experiments conducted in Atlantic City copper-steel resisted corrosion better than ordinary steel and that the comparison was about the same as in other atmospheres.

Electrolytic Pickling

The effect of the electrolytic pickling process on the physical properties of iron and steel was discussed by **John Coulson**, of the Westinghouse Research Laboratory, East Pittsburgh, Pa.

To determine the embrittling effect of absorbed hydrogen upon steel pickled in different ways, samples of spring steel wire were pickled chemically by simple dipping in acid, also by electrolytic pickling, using them as cathodes or as anodes. Oscillation tests on the original wires, the same sand-blasted, and the three sets treated as described, showed the chemically cleaned and the cathodically cleaned to be very brittle, while the anodically cleaned had the strength of the original samples. Similar tests were also made with drill-rod steel, hot-rolled Bessemer, and cold-rolled steel, after which mechanical tests were made as to strength, elongation and reduction of area. The chemically and the cathodically cleaned speciments again showed greater brittleness, which was most marked with the high-carbon steels and less marked with the soft steel.

Brittleness in Steel Springs

T. S. Fuller, of the Research Laboratory of the General Electric Company, Schenectady, N. Y., described interesting experimental work on the cause and prevention of brittleness in electroplated steel springs. The author does not agree with M. de Kay Thompson and C. W. Richardson (see this journal Vol. 16, p. 83) that hydrogen is not the cause of the trouble. He says:

The facts are all in accord with the assumption that the absorption by steel of atomic or nascent hydrogen liberated at the cathods is the cause of the embrittlement of steel springs in the plating bath.

This embrittlement may be prevented by first dipping the springs in a bath of molten tin. The tin forms a coating on the steel which is impermeable to atomic hydrogen. Rosin may be used as a flux in the tin dipping. The springs may be sand blasted, but must not be pickled in acid.

Steel springs may be dipped in molten tin at a temperature of 260 deg.—300 deg. C. without appreciably changing their mechanical properties.

In the author's experimental work he tested the

breaking strength of seven untreated springs, then tested similar ones electrically copper plated, pickled in sulphuric acid, and tinned by dipping in molten tin and then copper plated. The pickling makes them brittle, also copper plating, but tin-dipping before copper plating is found to prevent embrittlement entirely.

Corrosion of Metals by Acids

Oliver P. Watts and **Newton D. Whipple** of the University of Wisconsin described an interesting study of the rate of solution of zinc, amalgamated zinc, iron, copper, silver and gold, in various solutions at normal pressures and under a vacuum. The theoretical deductions are as follows:

1. The hypothesis of one of the authors, presented to this Society in a previous paper,[1] that the protective effect of arsenic on the corrosion of iron by sulphuric acid is due to polarization by hydrogen, is confirmed by the following facts:

(a) The corrosion by acids of iron protected by arsenic was invariably greatly stimulated by oxidizing agents.

(b) Arsenic does not protect iron from attack by corrosive agents which evolve no hydrogen by their action.

2. Amalgamation protects zinc from corrosion by acids because the discharge potential of hydrogen on mercury exceeds the potential of zinc. Protection by arsenic and by amalgamation are alike in their nature.

3. Tin and lead are only very slowly dissolved by non-oxidizing acids, although their potentials are such as would cause their ready solution in acids, if it were not for the unusually high discharge potential of hydrogen on them. Removal of hydrogen by an oxidizing agent causes these metals to dissolve readily in acids that otherwise corrode them very slightly.

4. Corrosion by acids, of metals below hydrogen in solution pressure or position in the usual electrochemical series, *viz.*, copper and silver, has been caused by the presence of oxidizing agents, and the reason for this action has been set forth in detail.

5. The oft-quoted statement that the corrosion of amalgamated zinc in dilute sulphuric acid is accelerated by a vacuum, has been shown to be incorrect. By removing the depolarizing oxygen of the air, reduction of pressure retards corrosion, not only of amalgamated zinc, but of other metals whose solution is hindered by a polarizing film of hydrogen.

6. As regards corrosion by acids, the metals experimented with, and probably all others, may be classified as follows:

(a) Metals whose potentials exceed the discharge potential of hydrogen on them; these dissolve readily in acids, except such as form insoluble salts.

(b) Metals whose potentials are less than the discharge potential of hydrogen on them; these dissolve readily in acids only in the presence of oxidizing agents. Gold and platinum are not readily attacked by the acids in general, even when these contain oxidizing agents.

7. The superiority of nitric over other acids as a general solvent for the metals—long recognized—is due to its being at the same time an acid and an oxidizing agent, which enables it to dissolve metals of the second class, which non-oxidizing acids cannot do.

8. Oxygen is necessary to success in cyaniding gold ores because in dilute cyanide solutions gold is a metal of the second class.

9 Measurements of the discharge potential of hydrogen in solutions of potassium cyanide and sodium hydrate, and experiments on the corrosion of metals in the latter, lead the authors to think that the above classification of metals, the action of oxidizing agents, and protection by other metals, will apply to the *dissolving of any metal in any electrolyte* from which it displaces hydrogen when passing into solution.

10. The above classification of metals according to the relative magnitude of their potentials in comparison with the discharge potential of hydrogen on them, applies not only to the solution of metals, but to their electrolytic deposition. Plating baths for depositing metals of the first class cannot be strongly acidified without causing the deposition of much hydrogen in place of an equivalent amount of metal; but a large proportion of acid may be added to solutions for the deposition of metals of the second class without greatly lowering the current efficiency through the deposition of hydrogen.

Mr. F. N. Speller stated that the principles discussed in the paper by Watts and Whipple had a bearing on the problem of the destruction of hot-water pipes carrying water for domestic use at 60 to 80 lb. pressure and a temperature of 160 deg. Fahr. He discussed experiments started several years ago on the removal of free oxygen from a hot-water system by running the water through chambers filled with sheets of expanded metal affording contact with a large surface of steel. By circulation of the hot water the steel sheets became corroded and the free oxygen was consumed primarily in keeping the surface of the plates active. The excess of hydrogen goes into solution. Soluble gas collected from this water gave the following analytical result:

	Raw	Treated
O	*17.6%	1.59%
H	0.3	22.17
CO_2	0.3	.12
N (by difference)	81.8	76.12
Temp.	160 deg.F.	162 deg.F.

*Low due to corrosion of iron storage tank and connections.

Free oxygen in the domestic water supply usually ranges between 5 and 9 cc. per liter, to which extent its depolarizing power is limited. After passing through the steel plates the water carries from a trace to 0.2 cc. of oxygen per liter. Improvement in the system described was noted by the absences of leaks which formerly were of weekly occurrence. New pipes installed for the test show practically no corrosion with the use of this "passive" water. The unbroken element of hydrogen on the inside of a pipe system of this kind is probably a more protective coating than any other so far devised.

Silver Peroxide

H. C. P. Weber, of the Westinghouse Electric & Manufacturing Company, in a paper on this subject discussed the black compound formed on the anode during the electrolysis of silver nitrate solution, and to which the formula $2Ag_2O_2AgNO_3$ has been ascribed. He discussed the probable valence of silver in the oxide part of this formula, writing it either Ag_2AgO_3 by analogy to red lead, or $Ag(AgO_2)_2$ by analogy to magnetic iron oxide. His various electrolytic experiments lead him

[1]Trans. Am. Electrochemical Soc. (1912), 21, 340.

to conclude that the last formula, $Ag(AgO_3)_2$, in which one-third of the silver is cathodic and diatomic and two-thirds anodic and triatomic, is in harmony with his experimental results. This would make Ag_3O_4 the silver salt of an argentic acid.

Catalysis

Two papers on this subject were presented by Dr. **W. D. Bancroft** of Cornell University. The first paper was on the theory of contact catalysis. The general conclusions drawn by Dr. Bancroft follow:

1. Only those substances which are adsorbed by a solid are catalyzed by it.

2. While the catalytic action of solids may be solely the result of the increased surface concentration in some cases, this is not always the only factor.

3. A solid catalytic agent may be considered as equivalent to a solvent and may therefore displace the equilibrium.

4. As a result of selective adsorption we may get different reaction products with different catalytic agents.

5. A catalytic agent tends to produce the system which it adsorbs the more strongly.

The second paper was on the poisoning of catalytic agents and led to the following interesting conclusions:

1. Since contact catalysis involves adsorption, a decrease in the adsorption will mean a decrease in the reaction velocity, other things remaining the same.

2. The adsorption may be decreased by the presence on the solid catalytic agent of a film of solid, liquid, or gas.

3. Very small amounts of grease will keep palladium from taking up hydrogen.

4. Carbon monoxide cuts down the catalytic action of platinum on oxyhydrogen gas and is itself oxidized slowly.

5. The preferential oxidation of carbon monoxide is not the reason for its poisoning the catalytic action of platinum on oxyhydrogen gas.

6. Carbon monoxide is retained tenaciously by platinum, and carbon monoxide practically destroys the catalytic action of platinum on hydrogen and ethylene.

7. Carbon monoxide undoubtedly decreases the adsorption of hydrogen and ethylene by platinum, though there are no direct measurements to show this.

8. Since the presence of the reaction products will decrease the rate at which the reacting substances will diffuse to the catalytic agent and since the reaction products may decrease the adsorption of the reacting substances, the reaction products may decrease the reaction velocity if they are not removed.

9. The reaction between carbon monoxide and oxygen in presence of platinum is accelerated by the addition of caustic potash to remove the carbon dioxide.

10. Sulphur trioxide decreases the rate at which sulphur dioxide and oxygen react.

11. If one reacting substance decreases the adsorption of the other, very much, presence of an excess of the first may decrease the reaction velocity.

12. When a mixture of carbon monoxide and oxygen is catalyzed by quartz glass, an increase in the concentration of the oxygen increases the reaction velocity, but an increase in the concentration of the carbon monoxide decreases it.

13. Since the poisoning of the hydrogen peroxide catalysis is due to selective adsorption, there is no necessary reason why the same substances should poison both platinum and haemase or should poison them to the same extent. On the other hand there is no reason why there should not be a certain parallelism, and that is all that actually occurs.

14. When a colloidal metal is kept in suspension by the addition of gelatine or other substance, the stabilizer may cut down the adsorption and consequently may tend to decrease the reaction velocity.

15. If the retarding effect due to the stabilizer in greater than the accelerating effect due to increased surface, a stabilized colloidal metal may be less effective than a pulverulent metal which is not handicapped by a stabilizer.

16. The action of mercuric cyanide, etc., in cutting down the electrolytic oxidation of thiosulphate is probably due in part to its decreasing the adsorption of thiosulphate at the anode.

In the discussion of this paper Dr. Fink pointed out that in 1907 he had published work on "Kinetics of Contact Sulphuric Acid," and "Adsorption Theory" which brought out the same ideas given in Professor Bancroft's papers. Acknowledging the excellence of Dr. Fink's early work, Professor Bancroft suggested that it was too far in advance of the thought of that time to receive the recognition it deserved.

Electrolytic Zinc

A paper on "The Future of Electrolytic Zinc" by **Thomas French** of Nelson, B. C., was read in abstract by Mr. Frary. It is hoped to publish this paper in full or a long abstract in a later issue.

* * *

At the close of the session the Society unanimously voted its thanks to the educational institutions and industrial organizations of Pittsburgh which had contributed so much to the success of the meeting.

In the afternoon, excursions were taken to various industrial plants in the Pittsburgh district including the benzol and by-product coke plant of the Briar Hill Steel Company and the new laboratory of the Youngstown Sheet and Tube Company, both at Youngstown, Ohio; the Atlantic Refining Company, Pittsburgh; Owens Bottle Works, Sharpsburg; Republic Chemical Company, Neville Island; and the Radium Research Laboratory of the Standard Chemical Company, Pittsburgh.

The banquet in the evening at the William Penn Hotel was a brilliant and enjoyable function. The evening was enlivened by cabaret and vaudeville entertainment features. Following the banquet Mr. Charles S. Witherell, recently returned from Chile, gave an illustrated talk on the plant of the Chile Copper Company, at Chuquicamata, Chile. Three reels of moving pictures were shown covering the mining and metallurgy.

On Saturday there was an all-day excursion by special train, with complimentary luncheon, through the manufacturing centers of the Pittsburgh district. This included the plant of the Westinghouse Electrical and Manufacturing Company, the National Tube Company, Duquesne Works of the Carnegie Steel Company, and the American Window Glass Company.

The Society is greatly indebted to the Pittsburgh local committee for the elaborate and painstaking arrangements made for the meeting.

Fractional Combustion*

By Wilder D. Bancroft

We may consider platinum black saturated with hydrogen, carbon monoxide, ethylene, methane, or oxygen as hydrogen, carbon monoxide, ethylene, methane, or oxygen electrode and from a measurement of electromotive forces, we can determine which one of the first four gases should oxidize the most readily in presence of platinum. So long as we assume that no one of the gases interferes with any of the others in a mixture we can predict what a mixture will do. If, however, a mixture does not behave in the way it should, there is a factor which we have overlooked in our calculation of the electromotive forces. If we consider the platinum, as we usually do, as a means of letting the chemical affinities have free play, the relative oxidizability of the different gases should be the same in presence of and in absence of platinum. If there is a difference in the two cases, the question at once arises to what extent the electromotive force calculated from the free energy of hydrogen and oxygen is really the true electromotive force of the hydrogen and oxygen gas cell. It is not my intention to answer either of these questions in this paper. I merely bring them up to show that a study of the theory of fractional combustion may be essential to a proper understanding of some electrochemical problems.

Many years ago Henry[1] made an interesting study of the effect of platinum on the fractional combustion of gases. Hydrogen and oxygen combine readily at ordinary temperatures in presence of platinum; carbon monoxide and oxygen react extremely slowly under the same circumstances; and neither ethylene and oxygen nor methane and oxygen react at all. When a mixture of methane and oxyhydrogen gas is exposed to platinum, the hydrogen burns and the methane does not. When a mixture of ethylene and oxyhydrogen gas is placed in contact with platinum some of the ethylene always burns. When a mixture of carbon monoxide with oxyhydrogen gas is exposed to platinum, there is a very slow reaction, the carbon monoxide burning more readily than the hydrogen.

Hydrogen is absorbed by platinum more strongly than ethylene and consequently it tends to burn first. Since ethylene does not burn at all under the same circumstances, it is possible, though not probable, that the combustion in presence of hydrogen is due to the oxygen passing through some intermediate stage in which it oxidizes the ethylene. That would make this an induced reaction. It seems to me more probable that we are dealing with a case of local heating, the ethylene burning at the higher temperature thus produced. This is the more probable since more ethylene is burned the greater the ratio of oxyhydrogen gas and the greater the ratio of oxygen. In fact Henry found that ethylene, when mixed with sufficient oxygen, began to burn in contact with platinum sponge at about 250 deg. and was converted completely into carbon dioxide at about 270 deg. Lunge and Harbeck[2] have shown that carbon monoxide is retained very tenaciously by platinum. It should therefore burn before hydrogen, and so it does. Methane is undoubtedly absorbed much less than either hydrogen or carbon monoxide, and this is in line with the fact that it is burned less readily under these circumstances.

Henry based a method of gas analysis on these observations. He found that by regulating the temperature carefully "the action of oxygen upon several gases (carbonic oxide, olefiant gas, and carburetted hydrogen, for example) may be made to take place in succession; and by removing the carbonic acid formed at each operation, it may be ascertained how much of each of the first two gases has been decomposed. The carburetted hydrogen indeed always remains unchanged, and its quantity must be determined by firing it with oxygen by the electric spark. If hydrogen also be present, it is difficult to prevent the olefiant gas from being partially acted upon; but this is of little consequence, as I had shown that it is easy to remove that gas in the first instance by chlorine."

This method of Henry's was afterwards worked out in more detail by Hempel,[3] substituting palladium for platinum. A mixture of hydrogen with an excess of oxygen burns completely when passed over palladium. The reaction begins spontaneously at ordinary temperatures, but so much heat is evolved that the palladium glows and the gases explode in case they are present in the ratio to form water. When methane and oxygen are passed over palladium at 100 deg. no combination takes place. The reaction starts at about 200 deg. Thus there was a contraction of 3 c.c. when a mixture of 29.3 c.c. methane and 70.6 c.c. oxygen was passed several times over palladium at about 200 deg. to 220 deg. When a mixture of hydrogen, methane, and air is passed over palladium at ordinary temperatures or at 100 deg., the hydrogen alone is burned and the methane remains unchanged, provided precautions are taken so that the palladium does not heat up too much.[4]

If a mixture of hydrogen and methane is passed over copper oxide at 250 deg., the hydrogen is burned completely, while the methane is not oxidized at all.[5] This method is said[6] to be distinctly superior to the fractional combustion of hydrogen by palladium or palladium asbestos because no air or oxygen is added to the combustible gas, which makes it possible to pass the total gas residue through the tube with consequent gain in the accuracy of the analytical results.

In view of the comparative readiness with which methane can be separated from hydrogen by the fractional combustion of the latter gas, it is not surprising that people came to the conclusion that hydrogen always burns more readily than methane. From experiments on the burning of illuminating gas, Landolt[7] concluded that in the flame "the gases disappear in the order of their combustibility. Hydrogen burns more readily than any other gas and consequently disappears the soonest in the flame. Marsh gas disappears somewhat more slowly, and the denser hydrocarbons disappear latest, burning chiefly in the upper half of the flame." It has been pointed out by Bone[8] that Landlot's results are vitiated by the fact that he used a platinum tube of

*A paper presented at the thirty-second general meeting of the American Electrochemical Society in Pittsburgh, Oct. 3-6, 1917.

[1]Phil. Mag., 65 269 (1825).

[2]Zeit. anorg. Chem., 16, 50 (1898).

[3]Ber. deutsch. chem. Ges., 12, 1006 (1879).

[4]*Cf.* Hempel; Zeit. angew. Chem., 25, 1841 (1912).

[5]Jäger: Jour. Gasbeleuchtung, 41, 764 (1898).

[6]Dennis; Gas Analysis, 199 (1913).

[7]Pogg. Ann., 99, 411 (1856).

[8]Phil. Trans., 215, 297 (1915)

narrow bore, fixed along the vertical axis of the flame for the withdrawal of the partly burned products.

Henry's experiments showed that carbon monoxide burned before hydrogen when in contact with platinum at relatively low temperatures and that hydrogen burned before carbon monoxide when the gases were exploded by an electric spark. This last remark is confirmed by Bunsen's experiments[9] given in Table I. More hydrogen is burned than carbon monoxide until the ratio of the second to the first is at least six. Henry[10] is quite explicit that the preferential burning of carbon monoxide in presence of platinum at 150 deg. to 170 deg. and the preferential burning of hydrogen when the gases are fired by the electric spark is merely a question of temperature. Presumably Bunsen and Landolt held the same view because they do not comment on the low temperature results, which they probably would have done had they considered these results abnormal.

TABLE I.

Volumes Before Firing			
CO	H_2	O_2	Ratio of H_2O : CO_2
7.36	2	1	0.85
5.98	2	1	1.08
4.87	2	1	1.28
5.03	2	1	1.29
3.90	2	1	1.53
2.82	2	1	1.83

A new light has been thrown upon the phenomena by Bone [11] and his co-workers. Bone was primarily interested in the way in which a hydro-carbon burns in a supply of oxygen insufficient to oxidize it completely to carbon monoxide and steam; but, as is usually the case, the scope of the investigations soon became much broader. A mixture of oxygen and the gas to be studied was sealed in cylindrical bulbs of borosilicate glass with capillary ends; the bulbs were then kept at constant temperatures between 300 deg. and 400 deg. for several days in an air bath until the whole or a part of the oxygen had disappeared. The lowest temperature at which a reaction between methane and oxygen could be observed after the lapse of two or three weeks was 300 deg. At 325 deg. the rate of reaction was much greater and at 350 deg. in some experiments the whole of the oxygen disappeared within three or four days, while at 400 deg. the oxidation was always completed in a single day. Hydrogen and oxygen at 350 deg. do not combine to any appreciable extent within a week or two, provided the glass surface with which the gases are in contact remains perfectly smooth. At 400 deg. the formation of water may be recognized within a week, but hardly within three days, whereas at this temperature the whole of the oxygen reacts with methane within a single day. Methane therefore combines with oxygen between 300 deg. and 400 deg. with an enormously greater velocity than does hydrogen under the same conditions. In a later paper Bone[12] says that "under similar conditions ethane burns much more rapidly than methane, and in borosilicate glass bulbs both hydrocarbons are oxidized at temperatures much below the limiting temperature (about 400 deg.) at which, under similar conditions, steam is formed appreciably from electrolytic gas." In a lecture before the Royal Institution Bone[13] showed that when mixtures corresponding to $C_2H_2 + 2H_2 + O_2$ and $C_2H_4 + H_2 + O_2$ are exploded there is no deposition of carbon and only a very slight formation of steam. The hydrocarbon has been burned to carbon monoxide and hydrogen, leaving the hydrogen of the original mixture absolutely untouched by the oxygen.

Experiments on explosions in bombs[14] showed that even at high temperatures there is preferential burning of methane. Bone concludes from experiments with the mixture $CH_4 + 2H_2 + O_2$ that "the ratio of the affinities [really reaction velocities] $CH_4 : H_2$ is of the order 20 or 30 to 1 at least, and probably higher if the influence of the walls of the containing vessel could be eliminated."

From the experiments of Henry, Landolt, and Bone, we see that hydrogen burns before methane at low temperatures in contact with platinum and at high temperatures when the gases are drawn off through a platinum tube. We see also that methane burns before hydrogen at moderate temperatures in borosilicate glass bulbs and also when the gases are fired by an electric spark. It is quite clear that a surface phenomenon is an important factor in changing the results. In Henry's experiments the platinum is unquestionably the cause of the preferential burning of the hydrogen and it seems probable that this is also true for Landolt's experiments. The existence of the water gas equilibrium with hydrogen as one of the constituents is fairly strong evidence that hydrogen is more stable than methane. Bone's results may therefore be considered as approaching at high temperatures the results due to free burning away from a surface. This is the more probable because he always finds a greater relative oxidation of methane in the larger bomb where the ratio of surface to volume is less. The existence of a surface factor is also shown by Bone's observation that about eighty per cent combustion of hydrogen occurs when the mixture $CH_4 + O_2 + 2H_2$ is passed over chamotte[15] at 500 deg. I do not know enough about the adsorbing properties of chamotte to know just why it acts as it does.

Since we can get almost complete preferential burning either of hydrogen or methane at moderate temperatures, depending on the nature of the surface, it is probable that a more extended study of different surfaces would give us all the intermediate values for the distribution of oxygen between methane and hydrogen just as Sabatier and Mailhe[16] have found all sorts of gradations between the reactions $CH_3CH_2OH = C_2H_4 + H_2O$ and $CH_3CH_2OH = CH_3CHO$ and H_2 when alcohol is passed over different heated metals or oxides. While I have not been able to find any definite studies along this line, there are some indications that special results might be obtained with special solids.

Calvert[17] showed that oxygen adsorbed by boxwood charcoal oxidizes ethylene to carbon dioxide and water at ordinary temperatures. This is not surprising because charcoal adsorbs ethylene strongly. Since charcoal has little or no effect in causing hydrogen and oxygen to combine, it is probable that we should get a preferential burning of ethylene in case a mixture of ethylene, hydrogen, and oxygen were brought in contact with charcoal. While this experiment seems not to have been tried, we do know that charcoal does seem to promote oxidation of carbon compounds.

[9] Bunsen: Ges. Abh., 2, 586, (1904).
[10] Phil. Mag., 65, 277 (1825).
[11] Jour. Chem. Soc., 81, 535 (1902) *et seq.*
[12] Jour. Chem. Soc., 85, 694 (1904).
[13] Proc. Roy. Inst., 19, 82 (1908).
[14] Bone: Phil. Trans., 215 A, 298 (1915).
[15] Bone: Ber. deutsch. chem. Ges., 46, 12 (1913).
[16] Ann. Chim. Phys. (8), 20, 341 (1910).
[17] Jour. Chem. Soc., 20, 293 (1867).

In the form of wood ashes, charcoal is often used in outhouses and elsewhere to eliminate unpleasant odors. The charcoal first adsorbs the odoriferous substances and then accelerates their oxidation, by oxygen which is adsorbed from the air. This dual function of the charcoal was pointed out clearly by Stenhouse[18] in 1854.

It is interesting to note that Bone's experiments on surface combustion led him to the conclusion that adsorption played an important part in the phenomenon. Bone[19] began by a study of the combination of hydrogen and oxygen in contact with hot surfaces of porcelain, magnesia, silver, gold, platinum, nickel, calcined spathic iron ore (containing 79.0 per cent ferric oxide and 14.5 per cent manganous oxide), nickelous oxide, and copper oxide. With each of these surfaces the rate is proportional to the pressure of the dry gas when electrolytic gas is used, is approximately proportional to the partial pressure of hydrogen when either gas is present in excess, and is increased by a previous treatment with hydrogen. In the case of porcelain, Bone decides that "porous porcelain occludes or condenses both hydrogen and oxygen at rates which depend to some extent upon the physical condition and past history of the surface. In general, however, whereas in the case of oxygen the process is extremely rapid and the surface layer is soon saturated, the occlusion of hydrogen is slower and the limit of saturation much higher. Combination between the occluded gases occurs at a rate either comparable with, or somewhat faster than, the rate at which the film of occluded oxygen is renewed, but considerably faster than the rate of occlusion of hydrogen."

The behavior of magnesium, "together with the fact that the material occludes hydrogen but not oxygen at red heat, shows that the catalytic action must be referred to the power of occluding hydrogen." The catalytic action of the four metals examined is due primarily "to an association of the surface with hydrogen—in the case of silver probably to the formation of an unstable hydride, in the other three cases to an occlusion of the gas. * * * The evidence in favor of the 'occlusion' theory is particularly strong in the case of nickel, where the 'normal' condition of activity can be reduced almost to the vanishing point by prolonged exhaustion at a comparatively low temperature. Moreover, the subsequent recovery of activity can be demonstrated by circulating successive charges of electrolytic gas over the surface under conditions which entirely preclude any chemical action of either of the reacting gases on the metal." "Considering the results obtained with the three different reducible oxides as a whole, they seem to be quite incompatible with any purely chemical explanation of the catalytic process. In the case of copper oxide it would appear to involve the condensation of a film of 'active' oxygen on the surface, and that this film actually protects the catalyzing oxide from the attacks of the hydrogen, which would otherwise reduce it energetically. At low pressures the film becomes too attenuated to ensure complete protection, and in consequence the formation of steam is accelerated by reason of hydrogen penetrating through onto the oxide and reducing it. In conformity with this idea, the rate of steam formation when the gases are not present in combining ratios was found to be proportional to the partial pressure of the oxygen.

"In the cases of the other reducible oxides examined, the fact that the gases combined at moderate temperatures, without permanently altering the surface, and at rates always far in excess of the rates at which either the surface was reduced by hydrogen, or the reduced surface re-oxidized, does not harmonize with the purely chemical theory.

The fact that the catalytic combustion depends on an intimate contact of the reacting gases with the surface is shown by the appearance of a piece of silver gauze before and after it had acted as catalytic agent for hydrogen and oxygen at 400 deg. The wires were originally very smooth, but after using they became quite rough. Bone[20] points out that at very high temperatures the specific nature of the solid seems to be relatively unimportant. At such temperature one would get practically no displacement of equilibrium by the catalytic agent because the reaction in the gas phase takes place so rapidly that the final equilibrium is that of the gas phase and not that of the catalytic agent.

The general conclusions drawn from this paper are:

1. At low temperatures the nature of the catalytic agent may determine which of two combustible gases will burn the more rapidly.

2. As might be expected, hydrogen burns more readily than methane or ethylene in presence of platinum.

3. From Landolt's experiments the same seems to be true in the flame provided a platinum tube is inserted; but these experiments should be repeated.

4. In presence of copper oxide at 250 deg. all the hydrogen in a mixture of hydrogen and methane can be burned without any methane being decomposed.

5. In presence of chamotte at 500 deg. hydrogen burns much more readily than methane. So little is known about the adsorption by chamotte that this result could not have been predicted.

6. In borosilicate glass bulbs at 300 deg. to 400 deg. methane, ethane, ethylene, and acetylene are oxidized much more rapidly than hydrogen or carbon monoxide.

7. When mixtures of methane, oxygen and hydrogen or carbon monoxide are exploded by an electric spark the methane burns much more rapidly than either the hydrogen or the carbon monoxide.

8. Depending on conditions, either hydrogen or carbon monoxide will burn the more readily.

9. Since charcoal causes ethylene to be oxidized to carbon dioxide and water, and since charcoal has very little effect on a mixture of hydrogen and oxygen, it is probable that charcoal would cause preferential burning of ethylene in a mixture of ethylene and hydrogen.

10. By suitable selection of the catalytic agent it should be possible to get all stages from complete burning of methane to complete burning of hydrogen.

11. Since relatively more methane was burned in the explosion experiments the larger the bomb, it seems probable that methane burns more readily than hydrogen at high temperatures and in the absence of solid catalytic agents.

12. At very high temperatures the specific effect of the solid catalytic agent must become negligible because the reaction will take place so rapidly in the gas phase that the equilibrium reached will be that of the gas phase and not that of the catalytic agent.

Cornell University.

[18] Pharm. Jour., 13, 454 (1854).
[19] Phil. Trans., 206 A, 1 (1906).
[20] Ber. deutsch. chem. Ges., 46, 14 (1913).

Physico-Chemical Properties of Chrome-Nickel Steels

By Herbert J. French

The results recorded in the following sections of these notes are designed to show the properties which may be developed by the heat treatment of certain chrome-nickel steels.

The steels used for these tests have been extensively employed during the past two years for automobile and airplane engine construction. In the writer's experience, which has included the development of the rotary aero engine in this country, these steels cover many of the needs of the manufacturer in such types of construction, where high tensile values together with good ductility are required. The results given will at least serve as a basis of comparison for many similar steels.

Standard tensile test specimens (.505 x 2 in.) were heat-treated in a laboratory electric furnace and the results thus obtained were then checked in actual production by including standard test sections in the ordinary charge for oil fired furnaces.

All temperatures are given in degrees Fahrenheit. The time of treatment of the test bars varied somewhat depending on the initial temperature of the furnace at the time the material was introduced and on the rate at which heat energy was applied. In the main, however, the steel was introduced into a furnace whose temperature was below 400 deg. Fahr. The average time of heating was about 30 minutes, the main idea being to allow the steel to remain in the furnace only long enough to become uniformly heated throughout.

In quenching, care was taken to introduce the steel into the oil as quickly as possible after leaving the furnace. It was then kept in motion in the oil for a period of about one minute. The oil used was Houghton's "No. 2 Soluble Quenching Oil."

The analyses of the steels considered in these notes are given below:

	C.	Mn.	Ni.	Cr.	Grade.
Heat "A"	0.35	0.64	1.47	0.50	Basic open-hearth
Heat "B"	0.43	0.52	1.16	0.72	Basic open-hearth
Heat "C"	0.45	0.51	1.19	0.98	Basic open-hearth
Heat "D"	0.39	0.36	2.56	1.01	Acid open-hearth
Heat "E"	0.24	0.36	3.19	0.98	Acid open-hearth

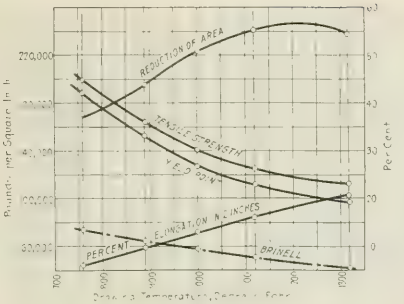

Fig. 2

Open hearth. Forged to about 1 in. round and heat treated. Oil quenched 1475 deg. Fahr. Drawn as given.

C	0.43	Ni	1.16
Mn	0.52	Cr	0.72
P + S	low		

Each of the above heats, made by the open-hearth process have phosphorus and sulphur below 0.04 per cent.

Curves and tables showing the physical characteristics of the various steels for varying heat treatments are given. Photomicrographs are also given for a few of the treated sections.

In the following sections a few results obtained on steels of the type represented by heat "C" are given for heats of varying carbon contents.

The uses to which these steels have been put has varied widely. In the main, the low alloys are to be preferred for forgings when these are to be made at one of the numerous drop forging plants. The chance of receiving material improperly worked under these conditions is greater for the higher alloys and when such a condition exists, only special methods of treatment can bring out the normal characteristics.

Also from the machining standpoint, the low alloy is to be preferred, depending of course, upon the machining operations necessary after forging. However, with careful workmanship and inspection at each stage of the production, all the above steels give very satisfactory results from a manufacturing standpoint.

It is not desired to convey the impression that the quantities measured in the tests recorded below are all that are necessary to determine the best steel for a

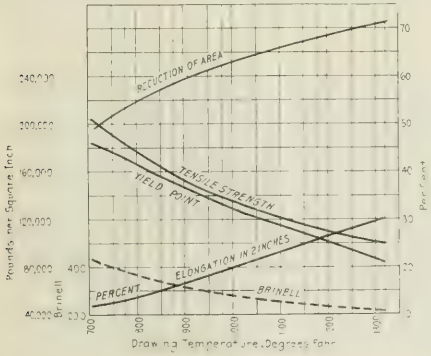

Fig. 1

Open hearth. Forged to about 1 in. round. Oil quenched 1470 deg. Fahr. Drawn as given.

C	0.35	Ni	1.47
Mn	0.64	Cr	0.50
P	0.014	S	0.023

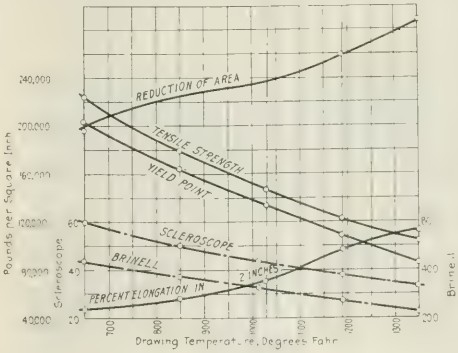

Fig. 3

Open hearth. Forged to about 1 in. round, then heat treated. Oil quenched 1450 deg. Fahr. Drawn as given.

C	0.45	Ni	1.19
Mn	—	Cr	0.98
P	low	S	low

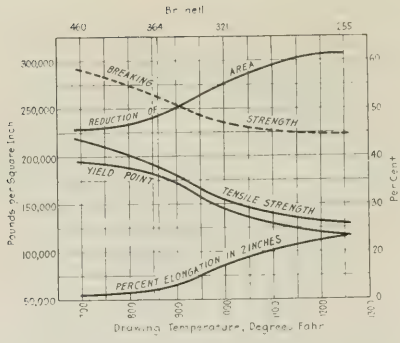

Fig. 4

Acid open hearth. Forged to about 1 in. round. Heat treated. Oil quenched 1475 deg. Fahr. Drawn as given.

C	0.39	Ni	2.56
Mn	0.36	Cr	1.01
P	0.016	S	0.016

given purpose. The results recorded are given so that an idea may be obtained as to what physical properties may be expected from certain commercial steels under tensile test after a given heat treatment has been applied.

In the following tables, yield point has been taken by the drop of the beam of the testing machine. Breaking strength as recorded is taken as the load in pounds recorded on the beam of the testing machine at the point of breaking, divided by the reduced cross sectional area. Brinell hardness numbers are for the standard test, using a 10 mm. ball under a load of 3000 kg.

The tensile test values of Tables 1 and 2, together with the corresponding curves, Figs. 1 and 2, will serve to give a good idea of the physical properties which may be developed by heat treating steels purchased to that standard specification:

	Per Cent.
Carbon	0.35-0.45
Nickel	1.00-1.50
Chromium	0.50-0.75
Manganese	0.50-0.80
Phosphorus, max.	0.04
Sulphur, max.	0.04

These two heats were chosen because they represented very nearly the widest limits of the specification.

Table 1

Heat "A"

Analysis:
Carbon, 0.35.
Manganese, 0.64.
Nickel, 1.47.
Chromium, 0.50.
Hammered to 1 in. round.
Heat treatment: Oil quenched from 1470 deg. Fahr. Drawn as given.
Results plotted in Fig. 1.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 725	198,600	180,400	12.0	49.8	418	57
Drawn at 780	181,000	171,700	13.0	53.2	381	55
Drawn at 880	161,100	150,300	16.0	58.4	321	50
Drawn at 980	138,600	128,500	19.0	61.7	286	44
Drawn at 1,180	114,800	103,500	25.5	68.2	241	37
Drawn at 1,320	98,400	83,000	30.0	71.3	207	37

Table 2

Heat "B"

Analysis:
Carbon, 0.43.
Manganese, 0.52.
Nickel, 1.16.
Chromium, 0.72.
Hammered to 1 in. round.
Heat treatment: Oil quenched from 1470 deg. Fahr. Drawn as given.
Results plotted in Fig. 2.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 760	199,750	189,200	11.0	42.8	364	50
Drawn at 880	164,400	153,400	14.5	48.7	321	48
Drawn at 1,000	141,300	126,800	18.0	55.8	286	45
Drawn at 1,120	124,300	111,300	21.0	60.4	255	35
Drawn at 1,320	112,500	96,990	25.5	59.4	207	33

Steel "C," a 1:1 nickel chrome alloy, has been very successfully employed for various purposes. When properly treated it does very well for such parts as crankshafts, connecting rods, valve lifters, etc. The steel works well under the hammer and machines easily. Results obtained on heats of varying carbon contents are given below.

Table 3

Heat "C"

Analysis:
Carbon, 0.45.
Manganese, 0.51
Nickel, 1.19.
Chromium, 0.98.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1450 deg. Fahr. Drawn as given.
Results plotted in Fig. 3.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 650	224,250	202,850	11.75	49.5	444	60
Drawn at 850	179,350	170,000	14.0	56.0	364	47
Drawn at 850	182,500	164,000	15.0	56.0	364	53
Drawn at 1,030	147,750	131,950	16.0	59.0	321	44
Drawn at 1,030	144,500	134,800	17.5	58.8	321	42
Drawn at 1,190	122,200	108,200	24.0	65.0	269	37
Drawn at 1,350	103,700	85,400	28.0	72.5	217	32
Annealed 1,450	93,800	58,600	25.5	62.0	187	25
As forged	109,470	73,480	22.0	68.0	187	29

Analysis:
Carbon, 0.22.
Nickel, 1.09.
Chromium, 0.95.
Phosphorus, 0.022.
Sulphur, 0.014.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1550 deg. Fahr. Drawn as given.

Deg. Fahr.	Tensile, Lb. per Sp. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 in.	% Reduct.	Brinell
Drawn at 425	243,500	.....	11.0	43.6	555
Drawn at 650	215,500	.....	11.5	49.5	430
Drawn at 800	197,200	181,000	12.0	55.0	418
Drawn at 800	194,000	177,150	12.0	59.8	387

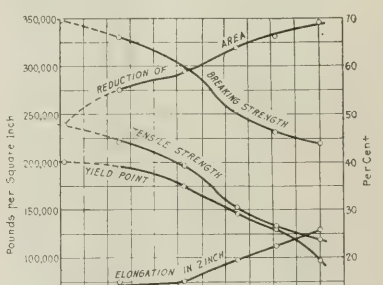

Fig. 5

Acid open hearth: as rolled: then heat treated. Oil quenched from 1475 deg. Fahr. Drawn as given

C	0.24	Ni	3.19
Mn	0.36	Cr	0.98
P	0.015	S	0.017

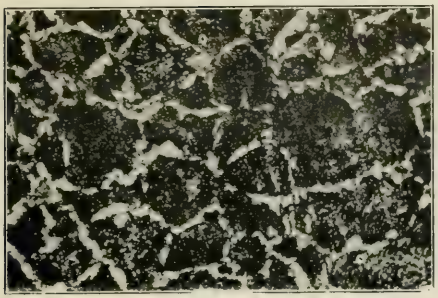

Fig. 6

C, 0.39; NI, 2.56; CR, 1.01. VERY MUCH OVERHEATED STEEL. COOLED IN FURNACE FROM 2000 DEG. FAHR. 100 MAGNIFICATION. ETCHED NITRIC ACID

Analysis:
Carbon, 0.61.
Nickel, 1.24.
Chromium, 1.11.
Hammered to about 1 in. round.
Heat treatment: Oil quenched from 1525 deg. Fahr. Drawn as given.

Deg. Fahr.	Tensile, Lb. per Sp. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Reduct.	Brinell
Drawn at 680	221,650	198,500	13.0	54.0	415
Drawn at 850	184,500	169,500	15.5	50.0	364
Drawn at 1,030	148,000	136,300	20.0	60.0	302

Table 4
Heat "D"

Analysis:
Carbon, 0.39.
Manganese, 0.31.
Nickel, 2.56.
Chromium, 1.01.
Phosphorus, 0.016.
Sulphur, 0.016.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1450 deg. Fahr. Drawn as given.
Results plotted in Fig. 4.

Drawing Temperature, Deg. Fahr.	Break. Str., Lb. per Sq. In.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell
700	291,300	217,000	194,400	11.25	45.7	460
860	262,500	188,700	178,200	12.0	48.3	364
1,000	234,600	154,150	145,550	17.0	52.7	321
1,000	233,100	148,150	138,900	17.5	54.9	321
1,250	223,700	127,850	117,000	23.0	61.3	255

Fig. 6 is a micrograph of this steel, very much overheated, and cooled in the furnace from 2000 deg. Fahr. Fig. 7 represents the approximate condition of the steel represented by the third line of the above Table 4.

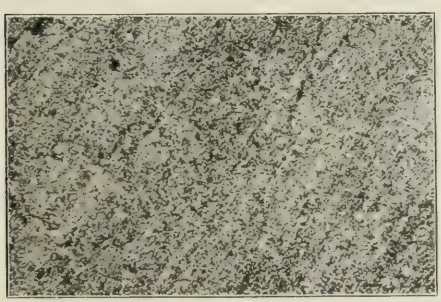

Fig. 7

C, 0.39; NI, 2.56; CR, 1.01. OIL-QUENCHED FROM 1475 DEG. FAHR. DRAWN AT 1000 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

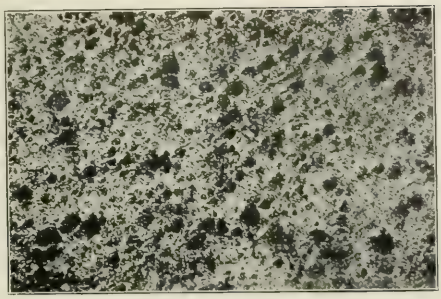

Fig. 8

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1475 DEG. FAHR. DRAWN AT 450 DEG. FAHR. TENSILE STRENGTH, 220,750; YIELDING POINT, 192,650; PER CENT ELONGATION IN 2 IN., 15.0; PER CENT REDUCTION OF AREA, 55.15. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

Table 5
Heat "E"

Analysis:
Carbon, 0.24.
Nickel, 3.19.
Chromium, 1.01-0.98.
Phosphorus, 0.028.
Sulphur, 0.016
Manganese, 0.36.
As rolled: Machined to standard test specimen.
Heat treatment: Oil quenched from 1475 deg. Fahr. Drawn as given.
Results plotted in Fig. 5.

Drawing Temperature, Deg. Fahr.	Break. Str., Lb. per Sq. In.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell
212	347,300	237,350	201,300	14.0	47.7	477
450	330,200	220,750	192,650	15.0	55.15	444
725	298,000	199,200	192,950	15.0	59.05	387
725		195,850	179,000	14.75	58.5	387
850	253,700	152,250	144,100	19.5	64.2	321
1,110	232,200	133,750	129,000	22.25	66.3	286
1,300	221,900	118,450	94,650	26.0	68.8	248

The microscopic structure of the steel approximately as shown in the second line of the above Table 5 is given in Fig. 8; of the fourth line in Fig. 9; and of the last line in Fig. 10.

With the above data at hand, a short discussion of the application of these steels and difficulties encountered in their use is given below.

The steels represented by the above five types have been used in connection with the development of the

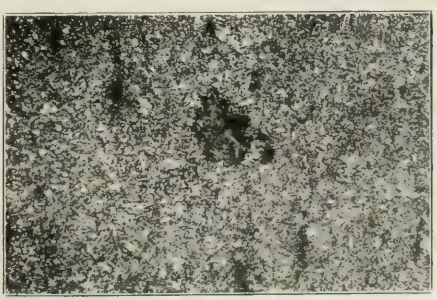

Fig. 9

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1450 DEG. FAHR. DRAWN AT 750 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

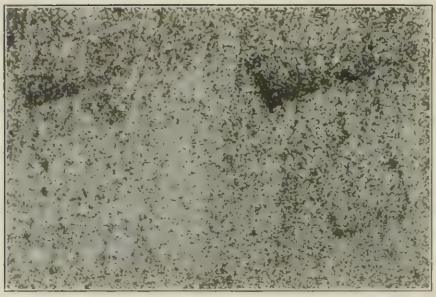

Fig. 10

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1450 DEG. FAHR. DRAWN AT 1300 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

Gnome type airplane engine in the United States.

These types of steels are also excellently suited for automobile work. Suitably heat treated, they have been used for the axles of small electric vehicles and for engine parts and transmission of gasoline trucks and pleasure cars. Particularly heats "B," "C," and "D" are to be noted. These steels, used for crankshafts, connecting rods, etc., have proven very satisfactory when properly fabricated and heat treated.

As mentioned previously, a steel similar to heat "D" is very susceptible to improper working under the hammer. The following remarks applying to this alloy, apply equally well to a lesser degree to the lower alloys. In other words, the lower chrome-nickel steels will stand more abuse in fabrication, and will under these conditions show the effects of the improper working to a less marked degree. Too rapid heating and especially heating in an open fire which leaves the center of the mass of metal "cold" and the outside "dripping," is to be avoided.

One of the most flagrant violations of the principles of metallurgy, came to the writer's notice some time ago in connection with this type "D" steel, of slightly higher carbon content. In reducing small electric furnace ingots to the proper sized billets for drop-forging, one shop subjected this steel to an open coke fire, causing an intense and localized heating of the end of the ingot, leaving a large portion and the center "cold." When reduced to the proper size under the hammer, the steel was absolutely worthless. However, more often the effect of cold working is less serious as when the whole mass of steel, uniformly heated, is hammered at too low a temperature. This condition of strain can be obliterated if proper heat treatment methods are employed. Long heating at rather high temperatures are often necessary which slows up and increases the cost of production.

The fact that under these circumstances the outside portion of the mass is burned aggravates the situation. Also, ordinary annealing may soften the steel so that a hardness test will show nearly normal results, but machining will still be difficult.

The same thermal principles entailed in the discussion above apply equally well to the heat treatment processes proper. Slow and uniform heating is essential for good results. Accurate temperature control and intelligent furnace operation are also necessary.

Chemistry and the Banker

Two very interesting and important addresses were delivered at the Chemical Exposition on Friday evening, Sept. 28, at a meeting of the New York Section of the American Chemical Society. The subject of the evening was "The Chemist and the Banker," and in view of its great importance and the need of closer relations between the two, we publish both addresses here in full. The chemists' side of the question was ably discussed by Dr. A. D. Little of A. D. Little, Inc., Boston, Mass., and the bankers' side by Mr. G. A. O'Reilly of the Irving National Bank of New York.

The Chemist

BY ARTHUR D. LITTLE

Most chemists know perfectly well what a bank is. It is an institution for minimizing the wear on paper money and is generally located in the best looking building in town. It works this way. You take your salary check to the bank before two o'clock and give it to a man in a cage whom you don't know. He writes $1,000 or may be only $65, in the little book you bring and you can then spend your salary without soiling a dollar of real money by simply writing other checks. Once in a great while, to hold your custom, this man writes in "interest 18 cents" in the little book and you spend Sunday in trying to find the error. Then the bank lends part of your salary to the United States Government for which it gets 2 per cent gold bonds against which it issues bank notes to enable it to pay rent and salaries, and it lends the rest of your check to railroads and manufacturing corporations and to farmers to move the crops. Its profit is the difference between the interest they pay and the 18 cents the bank pays you, as pointed out by Stanley Jevous in "Money and the Mechanism of Exchange."

Now the chemist goes at least once a month to the banker's bank whereas the banker seldom or never comes to the chemists' laboratory. It is not surprising therefore that the banker rarely acquires an equally clean-cut understanding of the relation of chemistry to the salary check he draws. To-night, with this great Exposition for our background, it is our privilege to enlighten him and I will ask the bankers present to kindly move into the front seats, without crowding.

Chemistry deals with the properties of matter and the changes which they undergo. Banking deals with the properties of money and the changes which they undergo. Money is merely a special form of matter set apart by agreement to facilitate the exchange of other forms of matter. The conclusion seems inevitable that banking is merely a department of chemistry like metallurgy or paper making.

The authenticity and fineness of the gold coin which constitutes the monetary basis is determined by chemistry. The mint is a chemical plant. Southern chemists get the best results from it.

It is chemistry rather than mining which is ultimately responsible for the amount of gold produced. The chlorination process and the cyanide process by rendering profitable the treatment of vast quantities of low grade ores profoundly affected the value of every ounce of gold in Christendom and the exchange value of all securities and commodities. But gold and the currency based thereon are only the exponents of indi-

vidual and national wealth. The commanding influence of chemistry becomes most apparent as we consider the true wealth of nations: the things which money and securities merely represent.

There is an unfortunate tendency among financial men to regard as chemical only those activities which have to do with the production of alkali and acids, dyes, explosives, synthetic drugs, and analogous materials within a narrowly limited field whereas there is hardly any industrial activity which does not from some point of view present a clearly defined chemical aspect. Agriculture thus becomes a department of photo-chemistry and the production of indigo by the plant under the influence of sunlight is no less a chemical process than its synthesis in a factory. When, however, that synthesis was accomplished in the laboratory, wise bankers began to scrutinize the credit of indigo planters.

Our national wealth is largely founded upon agriculture. Bankers annually bestir themselves to move the crops. There would be far less to move were it not for chemical fertilizers, chemical sprays to keep down the ravages of insects, and bisulphide of carbon which saved the wine industry of France and to which the American farmer is scarcely less indebted. By its utilization of the cotton seed, chemistry had added before the war at least $200,000,000 annually to the value of the cotton crop and the war itself is being fought with explosives made with cotton linters. Cotton is no longer merely a textile fiber. It is the raw material for great chemical industries, for the production of moving picture films, artificial leather, artificial silk, the endless varieties of celluloid, lacquers, aeroplane varnishes, dopes for patent leather and reinforced glass. Corn is still primarily a food crop but it has become much more. Chemistry has made it yield oil, dextrine, glucose, starches, and adhesives in great variety, thus bringing new grist to the banker's mill.

In every state and most conspicuously in Washington, chemical laboratories supported by the public funds attest the dependence of agriculture upon chemistry, which science thus becomes the fountain head of this great source of national wealth.

The securities based on steel production loom large before the banker but are rarely credited by him to chemistry. Yet making steel or aluminium, or extracting and refining copper and nickel, are as definitely chemical operations as making coal tar dyes. So with manufactures of the most diverse sorts, the tanning of leather, making bread, bricks, cement, lime, paper, coke, carbide, glass.

But wealth to be available for exchange must for the most part be transported and to facilitate such transportation great financial structures have been built up by bankers. Of these structures or the properties they represent chemistry is again the cornerstone. Who would build railroads or dig canals without Portland cement and dynamite, steel rails and bridge members? The Bessemer process alone, and chiefly because of its influence on transportation, was claimed by Abram S. Hewitt to add $2,000,000,000 yearly to the world's wealth.

A volume of fascinating interest could be written on the influence of chemistry upon the wealth of nations. The discovery of sulphuric acid caused wealth to flow in a broad stream to Sicily and the substitution of pyrites for sulphur threatened the island with bankruptcy. Not gold, but the cyanide process for extracting gold, established the prosperity of South Africa. The nitrate beds of Chile and the potash mines of Germany constitute national assets of the first importance because chemistry synthetized their values as it now in nitrogen fixation plants synthesizes wealth from air.

Although the chemist is still often made to feel that he is speaking a foreign language when talking to a banker, the events of the last three years have stimulated a rapidly growing appreciation in the minds of men of affairs and financiers of the fundamental importance of chemistry as a factor in national development and the basis of prosperity.

The time has come for chemists and bankers to find a common language and to establish a mutual understanding. The bankers need not prove that they can help the chemists, we admit it. We are not sure that they realize the extent to which we can help them.

Some bankers are finding it worth while to study Spanish because it leads them into a new financial world. It is in the power of chemistry to open up a new universe of finance.

Dewar has said that the whole object of the training of a chemist is to produce an attitude of mind. For what do men in hundreds daily risk their lives in aeroplanes over the battlefronts of Europe? They do it simply to get a new point of view from which the enterprise of armies may be directed by their commanders. Is it not then wise for the financiers who are the generals of industry to utilize to the utmost the scientific imagination, which is only logic in flight.

With due mental reservation for a few conspicuous exceptions, it may be said without much fear of contradiction that bankers generally seem to chemists to lack imagination and to experience a surprising difficulty in visualizing an unfamiliar situation. For instance, it hurts a chemist to see great quantities of raw material going to waste. It doesn't seem to hurt a banker very much. A chemist views with his mind's eye the vast potential wealth awaiting development by chemical methods, in the gas, oil, salt, sulphur and wood waste focussed in Louisiana. Frequent reference to it fails to arouse the enthusiasm of the banker, and very little happens. Evidently the chemist has not learned the proper formula for presentation of such large affairs.

In financing a cotton mill it is, I am told, possible to estimate the cost within a few cents per spindle. No such accuracy can be expected in case of a chemical plant, and particularly generous allowances must always be made where new processes are involved. Chemical investments in their early stages are undoubtedly speculative, and often highly so in character, but the speculative feature stands commonly in an inverse ratio to the amount of capital available for development. Important chemical enterprises should be initiated only by men with large reserves of capital and who wear thick woolen socks. Widows and orphans and small investors should keep away from them. Unless you can stay in it to the finish it is dangerous to get into a good thing too soon. By way of example: the first three companies organized by Count du Chardonnet for the manufacture of artificial silk, failed; stock in the fourth sold at $2,280. One can, on the other hand, point to highly successful chemical enterprises which have been established on an initial capital of $50,000

or less. What is particularly needed is a more direct approach to capital by chemists, through chemists.

In their contact with existing industries, banks are beginning to recognize that it is sometimes better policy to call upon a chemical engineer to set a business straight than it is to foreclose a mortgage. They do not always seem to appreciate, however, the extent to which the adequacy or the lack of chemical control of material and processes may affect the desirability of credit lines. A balance sheet does not always show where the dollars go in business. Many of them may be going up the chimney or down the stream, or into the slag pile. Many may disappear in low yields or products classed as seconds. A chemical audit of a plant is sometimes more informing than a balance sheet. Bankers, all the world over, are straining their energies to aid their governments in placing gigantic war loans. How shall these staggering burdens be carried and the obligations ultimately paid? The chemists' answer is: by conserving the values we already possess; by converting into actual wealth the vast potential values in raw materials now wasted; and by developing the estate.

If New England farmers cannot raise sheep because of vagrant dogs, let us intern those dogs. Since labor is scarce let us stop the nonsense I have just seen perpetrated by digging one trench instead of four to connect public services with a new building. Let us see if the simple expedient of making it difficult to insure flimsy construction and bad risks will not cut something substantial from our annual fire loss of $200,000,000. Through long years of peace and plenty dwellers in American cities have carried a heavy burden of municipal extravagance and inefficiency. Now is the time for us to realize that every dollar so wasted is a dollar filched from the fund for national defense. Equally serious to the nation and closer to the individual are the losses from preventable ill health. There are the yearly losses, amounting into billions from bad agriculture, bad packing, bad distributing systems, and the absence of dehydrating plants.

The suppression of these especially discreditable forms of national extravagance concerns banker and chemist and all good citizens. There are other colossal wastes which more directly concern the chemist in his professional capacity and the banker as a financial agent, wastes of coal and natural gas and yellow pine and cereal straw in amounts running into figures which sound like stellar distances and which seem to make about the same impression on the average mind. Suppose Niagara Falls ran coal instead of water, how long would we burn the coal at the base of the falls to make a spectacle and remain easy in our consciences?

The losses due to inefficient manufacturing, though indeterminate, are far greater than either bankers or manufacturers realize. They are in large measure subject to chemical control, and when thus minimized have often spelled the difference between disaster and dividends.

Suppression of the waste thus far enumerated would pay our war expenditures within five years, and thereafter make our country the financial reservoir of the world.

It is finally the mutual duty and opportunity of the banker and the chemist to co-operate in the development of the estate which is our country. To a similar end England has mobilized her scientists and made grants of over a million pounds to promote industrial research. Her manufacturers are organizing research associations to co-operate with the Government and divide the financial burden pound for pound. While the resources of our own country offer literally boundless opportunity for profitable research, we have still to utilize many research results of large importance which are immediately available.

To this extent the chemist, with his proofs in hand, now waits upon the banker.

* * * *

The Banker

BY G. A. O'REILLY

Under ordinary conditions and in normal times the spectacle of a banker presuming to address a body of chemists upon their exclusive and somewhat mysterious specialty, or indeed upon any other subject closely related to this specialty, would be rather unusual, perhaps a bit amusing, and certainly would suggest a quality of nerve which quite consistently and even profitably might be applied to some more heroic, although probably not more difficult, task.

Just where the theories of banking and the practice of chemistry come together is a subject which, it is feared, in the past, has not claimed the attention of banking circles to the extent to which its merit would appear to entitle it.

However, the conditions under which we meet are not ordinary conditions, and the times in which we live are not in the least normal times. Conditions are far from ordinary when throughout the world men may look out upon a situation strewn with the wrecks of institutions upon which men had learned to depend for safety and security and guidance, and where, as affecting the relations between men, race and creed and kin, have lost their meaning; and times are far from normal when, after a thousand years and more of Christian teaching and thought and inspiration, Christian men consistently may speak of saving the spirit of the world from the savage ferocity of Christian nations, and when each thought carries with it the shadow of a fear.

And so the task which, under other conditions, would be so difficult of treatment, becomes easy and alive and tangible because in it is found a wonderful possibility of treating some of the wonderful big things which have come into this new war-born field of national thought in which new institutions of the future must be created to take the place of those we have seen so ruthlessly destroyed.

These are wonderful days in which we live. Upon every hand are striking and unmistakable object lessons to point the way for us and to guide national thought and impulse. Recently it was my privilege to attend the deliberations of three of the country's great business conventions—the National Petroleum Association, the War Congress of American Business, under the auspices of the Chamber of Commerce of the United States, and the American Bankers' Association, all at Atlantic City and all held in rapid succession.

Under any conditions these would have been unusual gatherings; held as they were, at this time, and under the stress of war conditions, their normal importance

was vastly increased. Many interesting subjects were discussed and in masterly manner. Widely separated points of view and almost every possible shade of national business interest were represented.

Understand, they were not war conventions, nor were they characterized by any of the fervid war utterances with which the country was filled only a few weeks ago, and still, whatever the subject and however its treatment was begun, the discussion inevitably found itself moving along war channels, and the conclusions reached invariably were based upon war considerations.

Another striking characteristic of these conventions was found in the highly constructive quality of their deliberations. No time was wasted upon appeals to the patriotism of our people, or to their fighting spirit. The spectacular aspect of war nowhere was in evidence. The atrocities which the enemy is perpetrating under the guise of war received hardly a passing glance. No attempt was made to explain our presence or motives in the war, and above all there was no note of doubt or uncertainty as to either the seriousness of the war or its intimate relation to our national life.

It was as though the diverse and conflicting business interests of the nation, at last and in obedience to some unexpressed impulse which dominated the entire situation, had found a motive so big and so truly national that in its presence the sectional and personal quibblings of times of peace and security were unable to live.

The spirit of it was altogether splendid, and the lesson it taught full of inspiration. If such a spirit can be applied to a purpose like ours here to-night, the solution of our rather unusual problem, the determination of the proper relationship between even so divergent elements as chemistry and banking, should be easy—otherwise our time will be wasted, our effort fruitless, and discussions instead of bringing our respective specialties and viewpoints more closely together will only intensify the difference between them, and hence drive them farther apart.

The true relation of banking to chemistry is to be found only in the very simple and easily understood theory of practical business. The situation is not difficult unless we are unreasonably disposed to make it so. If the banker can relieve his function of the oppressive weight of self-constituted and unjustified importance under which it has struggled in the past, and bring it out into the open, and give it the sort of contact with other business institutions it needs and deserves, and if the chemist can emerge from the somewhat mysterious atmosphere with which unfortunately, through his fault or otherwise, he and his function have been enshrouded, and give the average business man a chance to realize how tangible and how intensely practical a business institution chemistry really is, the solution of the problem which forms the basis of discussion to-night will be found in the practical working out of the business transactions of every day.

Of course, to the banker or to any other layman, chemistry is difficult and mysterious and, until he is properly informed, rather apart from the business things of every day. But a little broadening of our general attitude toward the other man's specialty, a little fuller development of our powers of observation as we move through the business walks of life, and a little greater effort on our part to discover true relationships between apparently unrelated things will do wonders toward creating in us a respect for the intensely practical business possibilities for us which exist in the subject of chemistry.

In this direction Europe has gone much further than we. A few years ago I had occasion to make a rather thoroughly study of the co-operative institutions of Europe. Those of Denmark were found to be particularly interesting because of their high condition of development, and because of the extent to which the practical spirit of co-operation dominated the entire situation. The people of the country did not do much talking about getting together—they got together.

This wonderful little population of less than three and a half million people, able in normal times to sell annually in London alone more than $150,000,000 worth of bacon, butter and eggs, and practically to dominate that city's market in these lines, has not failed to give the chemist his proper place in the nation's economic plan, nor have they failed to utilize his equipment and services effectively in connection with the simple business details of every day.

To them the chemical laboratory is not, as unfortunately it appears to be with us, a rather remote institution to be resorted to only when normal methods of treatment fail to work, but rather an institution which is fundamental in even their simplest processes.

As a result of intelligent investigation and analysis, the farmer knows his different soils as he knows his friends, and treats them with what impressed me as rather greater consideration. If one of his crops is not performing up to the rather arbitrary standard decided upon by the co-operative agricultural society of which he is a member, his attention is directed to that fact by the society and the situation immediately is made the subject of investigation and treatment by the scientific establishment which is a serious part of the equipment of every well regulated Danish organization of this class.

If the milk product which he delivers to his co-operative dairy is deficient in some important element, the matter comes to his attention at once. The formula upon which he has been feeding his cows is inspected and, if necessary, a change is made to suit the requirements of the particular case.

If the eggs which he delivers to his co-operative egg export society are not up to a proper standard, his hens, their housing, diet and treatment immediately are made the subject of investigation, and again the remedy applied in whatever form is deemed most desirable, not by the farmer himself but by the scientific institution which speaks for the larger united interest of which the farmer is a part.

It is interesting too to learn that this service comes to the farmer not in a special or unusual way, but as one of the commonest details in the management of his farm, and practically without extra expense to him.

In the Philippine Islands a few years ago an effort was made, and with only modified success, to manufacture and introduce into the United States a ladies' summer hat made of the bamboo fiber. This is one of the most beautiful hard fibers in existence. It possesses every quality which reasonably could be demanded by the millinery trade, for a reasonably cheap, light, wide-

brimmed hat of fine finish and pleasing appearance. The bamboo is found in unlimited quantities in the Philippines, and the people are so expert in its treatment that a reasonably high-grade hat could be produced for not to exceed 50 or 60 cents. Such a hat, if it happened to be agreeable to the requirements of the American trade, should retail in the United States for from $3 or $4 upward.

At just about the time when this bamboo hat was beginning to promise commercial success in the United States there was developed a demand for hats in colors. The Philippine hat situation, because it lacked facilities for the proper treatment of bamboo fiber with color, was entirely unable to respond. It happened that there was not in the islands a color chemist. Experiments performed in the Government Bureau of Science and by private concerns were not satisfactory in their results. It was easy enough to color the fiber, but to treat it with fast colors and without dulling the very desirable bamboo surface was found to be entirely beyond the equipment of the local situation.

As a result, this hat, basically probably the best in the world of its general class, is practically unknown in the United States, and the Philippine Islands have lost a commercial product which if properly developed would represent at least half a million dollars per year.

I find the chemists' side of this evening's subject, which has been assigned to Dr. Little, and, as described by a Chinese cook I once had as "no b'long my pidgin," to be so exceedingly attractive that it requires an effort on my part to keep off the grass and talk about my own subject—the banker.

The other day I heard a man, a banker, say that banking was unfortunate in that it was parasitic—that it lived upon the lives of others and created nothing of its own. Of course he was wrong—altogether so—but, unfortunately, his remark only reflected an all too common estimate of the profession and an estimate for the existence of which bankers themselves are not a little to blame.

There is nothing in the nature of the bank, unless, perhaps, it be the banker, which should conduce to the creation of such an impression. If logically founded, properly equipped and intelligently directed, it can perform a business function in which the creative element figures as prominently as in production or manufacture or distribution.

The producer creates by transforming the riches of the earth into tangible and usable value, which he disposes of to his advantage. The manufacturer creates by changing the form and increasing the usefulness, and incidentally the value of the product, which he in turn disposes of, and to his advantage. The wholesaler and the retailer, without any essential change in the form of what comes from the manufacturer or the producer, sells the product, probably to a greater personal advantage than either of the others.

The banker, in a spirit differing in no essential from that which actuates the producer, the manufacturer, the wholesaler and the retailer, comes into these processes of production, treatment and distribution even more frequently and certainly not less importantly than any of the others. Indeed, we might say that his is the most important function of all in the carrying on of these processes.

The bank makes it possible for the farmer, the miner, the lumber man so to conduct their producing activities that if they proceed intelligently and consistently they always can find the financial means whereby operations may be continued and properly extended. In even a greater degree the manufacturer, the wholesaler and the retailer have learned to depend upon the bank for assistance. The treatment of commercial paper, whereby the immense commercial credit of the country may be utilized, transactions in connection with foreign trade, the conservation and investment of funds, the treatment of stocks, bonds and securities—all are functions performed by the bank and recognized by business men of all classes as vitally important in the nation's commercial life.

I have said that the true relation of banking to chemistry is found in the theory of practical every-day business. This theory must be taken seriously and literally by both banker and chemist if they are to derive the greatest benefit from each other and from business. Regardless of tradition and of possible personal inclination, they must descend from their respective pinnacles, whether of financial exclusiveness or scientific preoccupation, and get together in the intensely practical and really very comfortable atmosphere which the thoroughly up-to-date business man of to-day has created and prepared for them. If in doing this it becomes necessary to disturb an occasional delightful fiction, or to smash an occasional professional idol, it is believed that both may be done to the entire benefit of all concerned.

Just how much of a transformation in the chemist and in chemical industries must take place in order to produce the desired result, the chemist knows better than I. In any event, a substantial movement in the right direction has been made. A few expositions like this, and the conspicuous service which chemistry has rendered to business in recent years will leave no room for doubt as to the final outcome.

With the banker, too, the case seems exceedingly hopeful. Tendencies like those developed during the recent convention of the American Bankers' Association at Atlantic City indicate not only full realization, but also a large measure of practical assumption of the bank's responsibilities in the active business situation.

The banker of to-day—or rather of to-morrow—because it is with him that we are concerned, as the world does move, must be, first of all, a business man. He must be able to get away from the fictions of former years, in which the banker, because of his intimate association with money, became obsessed with the idea that he and money were of the very essence of each other and that they mutually reflected each other's virtues for the general edification of mankind. He must be able to speak the language of business, to meet the business man upon business grounds, to discuss with him business problems, and, by his ability to provide the remedy required, must even prove himself to be the better business man of the two.

He must realize that in the larger sense the bank must depend upon business and not business upon the bank—that in the great mass of institutions indispensably connected with business activities the bank is only one, and not by any means the most important one.

This banker of the future must enter into the business life of the community more extensively and more

actively than in the past. He must so equip himself and his institution as to be fully prepared to perform whatever function may be submitted to him by the business of the situation of which he is a part. Upon business questions which come to him for treatment, his function must be that of a specialist—a sort of physician for the treatment of ills which affect the life of business.

It may seem that this is an unreasonably high standard of business excellence to be required of a man already deeply immersed in the purely financial details of his institution, but the developments of modern business leave no doubt as to the nature of its requirements upon him. The pace which he must observe is being set for him without any particular reference to his inclinations or to the business habits which he may have formed. The developments of modern business demand certain classes of banking service, and also demand that in providing this service the bank perform up to a certain standard of excellence.

Naturally, a discussion at the present time upon two such nationally important subjects as chemistry and banking, particularly in relation with business, would include consideration of the greatest business enterprise in which this or any other nation ever has taken part—the war.

The theory that the true relation between chemistry and banking is found in business finds considerable justification even in conditions existing before the war. When viewed in the light of the big, wonderful new things which war has brought into the world, the conclusion becomes irresistible. The indifference with which in former years private interest viewed national problems and difficulties finds but slight resemblance in the magnificent response which business everywhere has made to the nation's call.

And so, while in considering the business relationship between chemistry and banking we should concede sufficiently to the business advantages which will result to both from a proper getting-together, we must not lose sight of the fact that the big thing in this relationship will be the national interest. For us there are just two worth-while things in the world to-day—one, to win the war; the other, to protect American interests afterward. Naturally, winning the war comes first, but preparations to that end should be definitely based upon the understanding that wars are to be won principally that nations may live in greater peace and security.

We must realize that the friendships and alliances of war need not control the international relations of the future. We must not forget that the ancient struggle for commercial mastery of the world is based upon conditions which will exist until the end of time, and that this struggle will be taken up again upon the day when peace is declared, not less strenuously than before, and that in it we must be prepared to protect our own interests in peace no less seriously than we now protect them in war.

Increased Exports of Manufactures.—According to a statement issued by the Bureau of Foreign and Domestic Commerce, 78 per cent of the more than six billion dollars worth of American goods exported during the year ending June 30, 1917, consisted of wholly or partly manufactured goods. Chemicals, dyes, etc., amounted to 182,040,380 as compared with $22,714,611 in the year ending June, 1914.

Storage, Weathering and Spontaneous Combustion of Coal

A committee of the National Electric Light Association has collected much data in connection with the problem of storing coal and finds that the literature on this subject is voluminous and also contradictory.

The matters to be considered in connection with storage and which have to be given due weight by the purchaser involve the question of losses due to weathering and those due to spontaneous ignition.

WEATHERING

The weathering of coal is a question on which much difference of opinion exists. There have been statements made to the effect that all bituminous coals lose in calorific values largely and continuously. This point of view has not been confirmed by investigators who have made extensive studies of the problem. To dispose of this feature, the following quotations from the publications of the Bureau of Mines and the University of Illinois Experiment Station can safely be accepted as authoritative and conclusive.

TABLE I

CALORIFIC VALUE (IN GRAM CALORIES) OF THE COAL SUBSTANCE (MOISTURE, ASH, AND SULPHUR FREE COAL) BEFORE AND AFTER STORAGE

Kind of Coal	Storage Conditions	Place	Calorific Value: As Stored	After 3 Months	After 1 Year	After 2 Years	Percentage of Loss in 2 Years
New River, W. Va.	¼-inch coal, under sea water.	Portsmouth, N. H.	8761		8759	8730	0.39
		Norfolk, Va.	8754		8763	8737[b]	.40
		Key West, Fla	8747		8732	8770	0
	¼-inch coal, under fresh water	Pittsburgh, Pa.	8752	8762	8749	8760	0
	¼-inch coal, exposed to air indoors.	Portsmouth, N. H.	8779	8738	8742	8709	.80
		Norfolk, Va.	8751	8742	8736	8717	.39
		Key West, Fla.	8754	8728	8676		
		Pittsburgh, Pa.	8769	8736	8719	8720	.56
	R. O.M. coal exposed to air indoors.	Portsmouth, N. H.	8754	8758	8748	8734	.23
		Norfolk, Va	8743	8764	8725	8725	.21
		Key West, Fla.	8745	8733	8710		
		Pittsburgh, Pa.	8753	8758	8740	8743	.11
	¼-inch coal, exposed to air outdoors, uncovered.	Portsmouth, N. H.	8741	8730	8701	8674	.77
		Norfolk, Va.	8734	8709	8666	8625	1.16
		Key West, Fla.	8739	8721	8680	8592	1.85
		Pittsburgh, Pa.	8763	8726	8700	8665	1.12
	R. O.M. coal exposed to air outdoors, uncovered.	Portsmouth, N. H.	8775	8766	8760	8722	.60
		Norfolk, Va.	8743	8745	8720	8695	.55
		Key West, Fla.	8762	8708	8722	8632	1.29
		Pittsburgh, Pa.	8752	8740	8716	8696	.64
Pocahontas, Va.	120-ton pile, r.o.m. coal outdoors	Panama	8794	8787	8762		
Pittsburg bed	¼ tons r.o.m. coal in open bin, outdoors.	Ann Arbor, Mich.	8541	[c]8539	8526		
			8541	[d]8553	8528		
Sheridan, Wyo., subbituminous	R.O.M., open bin, 5 ft. deep.	Sheridan, Wyo.	7370	7174		7135	[f]3.19
	R.O.M., closed bin 5 ft. deep	Sheridan, Wyo.	7370	7202		7094	[f]3.75
	R.O.M., closed bin, 15 ft. deep.	Sheridan, Wyo.	7370	7303		6982	[f]5.26
	Slack, closed bin, 15 ft. deep.	Sheridan, Wyo.	7355	7166		6990	[f]4.96

[a] Heating value of representative mine sample of coal (ash, moisture, and sulphur free) 8,768 calories.
[b] On basis of original heating value of same test portion.
[c] After six months' storage, entire lot in bin
[d] After six months' storage, upper 6 inches at surface of bin.
[e] Each bin contained 5 to 10 tons.
[f] After two years and three-quarters.

Table 1 gives a condensed summary compiled from the results of a large number of tests and determinations. The moisture, ash, and sulphur contents and calorific value of each sample were determined. A Mahler bomb calorimeter and a carefully calibrated Beckman thermometer were used in the calorimetric work, and nearly all the work was done by one of the authors and with the same calorimeter. To eliminate the effect of incidental impurites that were not concerned in the deterioration of the actual coal substance, the calorific values are calculated to a moisture-, ash-, and sulphur-free basis, and the ash as determined is corrected for errors due to oxidation of pyrites and dehydration of shale or clay.

The results show in the case of the New River coal a loss of less than 1 per cent of calorific value in one year by weathering in the open. In two years the greatest loss was at Key West, 1.185 per cent. There was practically no loss at all in the submerged samples in one year, fresh or salt water serving equally well to "preserve the virtues" of the coal. There was almost no slacking of lumps in the run-of-mine samples. In all tests the crushed coal deteriorated more rapidly than the run-of-mine.

The Pocahontas run-of-mine coal in 120-ton pile on the Isthmus of Panama lost during one year's outdoor weathering less than 0.4 per cent of its heating value, and showed little slacking of lumps.

Gas coal during one year's outdoor exposure suffered practically no loss of calorific value measurable by the calorimetric method used, not even in the coal forming the top 6-in. layer in the bins.

The Wyoming coal in one of the bins deteriorated in heat vaule 5.3 per cent during storage for 2¾ years, and more than 2.5 per cent in the first three months. There was bad slacking and crumbling of the lumps on the surface of the piles, but even where this surface was fully exposed to the weather the slacking did not penetrate more than 12 to 18 in. in the 2¾-year period.[1]

The Bulletins Nos. 17 and 38 of the University of Illinois Engineering Experiment Station are well worthy of study in connection with this subject.

Heating and spontaneous combustion of coal are caused by absorption of oxygen by both the organic and inorganic constitutents and are more active in coals exposing large surfaces to chemical action. In other words, lump coals generally absorb oxygen to a lesser degree than slack coals because of the relatively smaller surfaces exposed to the action of the atmosphere.

A pile of coal is, in itself, a very poor conductor of heat. This is shown by the fact that fire has often been detected within a very few feet of thermometers placed in the pile to check rise of temperature.

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The oxidation of coal is continuous over a wide range of time and conditions, and begins (at ordinary temperatures) with the freshly mined coal. A number of oxidation processes are involved, which are more or less distinct in character, some being relatively slow and moderate in form, while others are rapid and vigirous in their action.[2]

In general it may be said that for a given coal a point exists, as indicated by the temperature, below which oxidation is not ultimately destructive. The continuance of this point is dependent upon certain accessory conditions; if these conditions are withdrawn the oxidation ceases. On the other hand, above this critical point, which is best indicated by temperature, oxidaton is ultimately destructive and is characterized by the fact that it does not depend for its continuance upon external conditions, but is self-propelling or authigenous.

The point of authigenous oxidation, while varying for different conditions, may be indicated by the temperature of the mass ranging from 140 deg. to 160 deg. C. in an atmosphere of oxygen, or approximately between 200 deg. to 275 deg. C. in oxygen diluted with nitrogen, as in air, depending to a great extent upon the fineness of divisions. The phenomenon of fire or actual kindling does not occur until a much higher temperature is reached, usually beyond 350 deg. C.

The temperature at which authigenous oxidation begins is the sum of numerous temperature components, each one of which, either because of its own contribution to the total heat quantity or because of its function as a stimulus for chemical activities, must be looked upon as a dangerous factor, tending directly to the ultimate result of active combustion throughout the mass. An enumeration of the more important elements which contribute toward this end follows.

(*a*) *External Sources of Heat:* Oxidation, especially of the lower or moderate form, is greatly accelerated and in certain phases directly dependent upon an increase of temperature. What may be external or physical sources of heat, and thus presumably avoidable, are suggested by the following list:

(1) Contact of the mass with steam pipes, hot walls or floors under which are placed heat conduits of any sort.
(2) The heat of impact or pressure due to the method of unloading or to the depth of piling.
(3) Climatic or seasonal temperature at the time of storage.
(4) Direct absorption of heat from the sun or from reflecting surfaces.

(*b*) *Fineness of Division:* Coal in a fine state of division presents a very much larger surface and brings a much larger quantity of reacting substances in contact with oxygen than when in solid masses. Under these conditions, with a condensation or accumulation of relatively large amounts of oxygen immediately surrounding or in contact with the particles of carbonaceous matter, the circumstances are exceedingly favorable for rapid oxidation upon the arrival of the mass to a suitable temperature. But more especially does this fineness of division facilitate the initial form of oxidation described under (*c*).

(*c*) *Easily Oxidizable Compounds:* A first or initial stage of oxidation exists in bituminous coals which does not result in the formation of CO_2. Unsaturated compounds are present in coals of this type, which have a marked avidity for oxygen at ordinary temperatures, the products being humic acid or other fixed constituents of the coal texture. Coals vary widely in this respect, and it has been proposed by some to regard this content as an index of the liability to spontaneous combustion. It is, however, very largely dependent upon the freshness of the coal and upon the fineness of division (see *b*), and should be looked upon as a contributing factor, although in coals of the Illinois type, at least, with their high percentage of sulphur, this action should doubtless be considered second in importance to that of iron pyrites.

(*d*) *Iron Pyrites:* The presence of sulphur in the form of iron pyrites is a positive source of heat due to the reaction between sulphur and oxygen. This may be conveniently referred to as the second stage in the process of oxidation. Here again rapidity of oxidation is directly dependent upon fineness of division. Since coals, as a rule, have a much higher earthy or ash content in the fine dust, and since iron pyrites is a large component of this material, it follows that the presence of dust in all coals of the Illinois type is a positive source of danger. Since the majority of coals of the Illinois or mid-continental field run over 6 per cent pyrites, the heat increment from the oxidation of only one-fifth of this material is sufficient to raise the temperature of the mass approximately 70 deg., assuming that there is no loss by radiation. Under usual conditions, and especially considering the greatly accelerated rate of chemical activity accompanying a rise of temperature, this oxidation may proceed with such

[1]Technical Paper No. 16, Dept. of Interior, Bureau of Mines.
[2]Bulletin No. 46, University of Illinois, p. 50.

rapidity that the heating up of the mass will be but little affected by loss of heat due to radiation, except in relatively shallow piles.

(*e*) *Moisture:* While essential to pyrite oxidation, moisture is given separate mention because its importance is apt to be under-estimated. The oxidation of any coal will be facilitated by moisture under favorable conditions. It is to be noted in this connection that the normal water content or vein moisture of coals in this region is rarely below 10 per cent and ranges usually from 12 to 15 per cent. The presence of such water must be borne in mind in considering the likelihood of chemical activity on the part of the pyrites present. Without exception, in all the series of tests the wetting of the coal increased the activity, as shown by the ultimate temperature.

(*f*) *The Oxidation of Carbon and Hydrogen:* A third stage in the oxidation of carbonaceous material exists by reason of the tendency of certain of the hydrocarbon compounds of coal to oxidize with the formation of CO_2 and H_2O at temperatures in excess of 120 to 140 deg. Although this type of oxidation does not appreciably take place at ordinary temperatures, it must be looked upon as an exceedingly dangerous stage in the process, owing to the very much higher quantity of heat which is discharged by the oxidation of carbon and hydrogen, so that the temperature of authigenous action, although ordinarily occurring at a higher point by 100 deg. or more, may be quickly attained as a result of this form of oxidation. Any initial heat increments, therefore, which threaten to bring the chemical activities along to the point where the oxidation processes invade the carbonaceous material in this manner must be looked upon as dangerous. For example, any of the initial or contributory processes which result in raising the temperature of the mass 50 deg. above the ordinary temperature would, in all probability, have enough material of the sort involved in such action to continue the activity until another 50 deg. have been added, and would thereby attain to the condition wherein this third type of oxidation would begin.

The fourth stage of oxidation may be indicated as occurring at temperatures above 200 to 275 deg. and differs from the previous stages in that the action is authigenous and not dependent upon other sources of heat to keep up the reacting temperatures. Activity in this stage is further accelerated by the fact that above 300 deg. the decomposition of the coal begins, which is exothermic in character, thereby contributing somewhat to a further increase in temperature. The ignition temperature is reached at a point still further along, usually in excess of 300 to 400 deg. C.

PREVENTIVES

The above formulation of the various stages and types of oxidation clearly indicates the principles which must be observed in any attempt at the prevention of spontaneous combustion. The following enumeration, therefore, of preventative or precautionary measures is to be suggestive rather than complete in character.

(*a*) The avoidance of an external source of heat which may in any way contribute toward increasing the temperature of the mass is a first and prime essential.

(*b*) There must be an elimination of coal dust or finely divided material. This will reduce to a minimum the initial oxidation processes of both the carbonaceous matter and the iron pyrites. These lower forms of oxidation are to be looked upon as forces, without which it would be impossible for the more active and destructive activities to become operative.

(*c*) Dryness in storage and a continuation of the dry state, together with an absence of finely divided material, would practically eliminate the oxidation of the iron pyrites.

(*d*) Artificial treatment with specific chemicals or solutions intended to act as deterrents does not offer great encouragement, though some results seem to warrant further trial in this direction.

(*e*) By means of a preliminary heating, the low or initial stages of oxidation are effected. These sources of contributory heat being removed, the forms of destructive oxidation are without the essential of a high starting temperature and are therefore inoperative.

(*f*) The submerging of coal, it is very evident, will eliminate all of the elements which contribute toward the initial temperatures. As to its industrial practicability, like the conditions under (*e*), this can best be determined by actual experience.

(*g*) Other processes may be suggested by the formulation of the principles involved. Such, for example, would be the distribution throughout the coal of cooling pipes through which a liquid would circulate having a lower temperature than the mass. This would serve to carry away any accumulation of heat and confine the oxidation to the lower stages only. The proposition sometimes made to provide circulating passages for the transmission of air currents is, on the contrary, of questionable value, since it might by the added accessibility of oxygen result in the contribution of more heat than would be carried away by the movement of the air.

STORAGE UNDER WATER

For complete protection of coal from spontaneous heating the only sure method to-day is the storage of coal under water. This method is used by the United States Government at its coaling stations on the Panama Canal, by the Western Electric Company in Chicago, and in other places. The objections to this method are the moisture contained in the reclaimed coal and the liability of freezing in localities where low temperatures prevail.

Two methods of storing coal are in general use, one where the storage is purely a reserve and the coal is of such character as will store without material loss; the other is where spontaneous heating is to be expected. This indicates the advisability of using the storage pile for freshly mined deliveries, withdrawing from it for daily use. This last method is applicable without large additional expense only to storage piles adjacent to generating plants.

It is very difficult to arrive at a definite conclusion regarding the qualities and characteristics of coal that can be stored without danger of spontaneous heating. A fair assumption is that coal which has such characteristics as enable it to resist atmospheric influences resulting in air slaking, is better suited for storage than coal of opposite characteristics. The presence of sulphur and moisture has a bearing on the subject, but contrary to many expressed opinions, as indicated above, it seems reasonable to conclude that sulphur is not a governing factor, but simply one of many causes. Moisture in small quantities without doubt accelerates

the absorption of oxygen and increases chemical activity. In connection with the sulphur content of coal and its effects on spontaneous heating, it should be noted that the instantaneous combustion of 1 per cent sulphur in the coal would raise the temperature to about 135 deg. F. This rise in temperature is entirely insufficient to bring the coal to a point of ignition, and it must be borne in mind that the oxidation of the sulphur must necessarily extend over a considerable time during which radiation from the pile would generally dissipate all of the heat.

Many authorities have recommended that stored coal be piled not to exceed 12 to 20 feet in depth. Undoubtedly where space limitations are not to be considered, such advice is good, but it must be borne in mind that the depth of the pile affects practically only the loss of the heat in the pile itself by radiation and convection. Therefore, no arbitrary height can be set as a limit for coal storage piles, as this depends largely on the nature of the coal stored. It has been a matter of general observation that freshly mined coal heats more rapidly than coal which has been exposed to atmospheric conditions for some length of time. Therefore, it has been necessary in certain cases to rehandle freshly mined and stored coal after a short period, exposing the coal to the atmosphere and allowing it to cool down by radiation, and then restocking it, after which there has been no trouble from heating.

This has not been the experience with all observers, but in all probability the different results which have been noted were due to differences in the characteristics of the fuel both as regards constituents and size.

It must be borne in mind that one of the most important considerations in connection with coal storage is the matter of size. As has been noted already it is the surface of coal exposed to atmospheric conditions that governs the absorption of oxygen. Lump coal becomes oxidized on its surface and after absorption to a small degree is practically inert unless such oxidation results in a breaking up of the lumps, although even without this breaking up there may be more surface exposed by the creation of fissures or a crazing of the surface.

In all of the literature consulted, the Committee has found no case on record of lump coal having suffered from spontaneous ignition. This is true for coals of widely different characteristics, and is as true for high volatile gas coals as for low volatile steam coals. Where, however, coal is stored with a large percentage of slack, heating to some extent is practically universal. Rehandling has checked further heating, but if left in the pile spontaneous ignition is bound to occur.

The Committee has undertaken no research work in connection with this problem, the plan being to gather in a practical way such ideas and suggestions as may be of use of those who have the storage problem in mind. Protection of storage piles by admitted ventilation has proved more dangerous than no protection. Suggestions have been made for the introduction of gases which will not support combustion and of steam for subduing fires already in progress, but such methods have not as yet been marked by any pronounced success. It can be accepted as final that eternal vigilance in the handling of stock coal is the only way by which loss can be guarded against. Checking rise of temperature is a good method, but it must be borne in mind that because of the poor conductivity of coal fires may exist within very short distances of points of observation.

The Treatment of Metallurgical Smoke in Japan

By Tetsurow Komakine

The European wars have stimulated the industry of metallurgy in Japan, especially copper metallurgy. At the same time almost a dozen cases of smoke damage were raised by tenants and the landlords.

Now there are two main investigations of the treatment of metallurgical smoke in this country; one is being undertaken at the Hitachi Mine, the other at the Ashio Mine, which are the largest copper producers in this country. It will be of the most interest to discuss separately their methods of attacking the problem.

Recently at the Hitachi Mine an aircraft (perhaps it is better to say a sack filled with hydrogen) was utilized to examine the air currents at great heights above the mine. This will no doubt furnish much needed data to aid in solving the smoke question. At the mine hitherto careful attention has been given to the smoke ejected from the present chimney, 511 ft. high (it is called the tallest one in whole orient) which is built on a mountain about 700 ft. above sea level. In these investigations many field laboratories were erected at intervals on the circumferences of circles (ranging from one mile to some fifty miles in radius). These estimated the SO_2 gas in the air at the respective positions, and attempted to reach some conclusions concerning the relation between the distribution of gas in air and the air currents, as well as to study the harm due to the smoke itself.

It has been generally thought that when the smoke is discharged from the chimney, the further the distance from it the more diluted the gas will be with air. That is, the concentration of the gas in air is inversely proportional to the distance from the chimney. But after these investigations were finished, the facts appeared to be quite contrary to this theory. The supposition above mentioned is not always true, since they sometimes found a higher concentration of SO_2 at a greater distance from the chimney, while they also found lower percentages of it at short distances from the mine. And both the SO_2 content of the air and the place where the maximum appears are quite variable and fortuitous. In a certain season, point "A" has the densest smoke of all places, while in the next season place "B" is the densest, while in the next, place "C." Even the change of this concentration is very irregular, and beyond prediction.

For these reasons, it was impossible to estimate the damage of smoke from such skin-deep studies. Consequently not only a study of the gas conditions at the ground but another of the upper air currents was thought necessary. In these experiments it is planned to sample the upper air by means of the aircraft in order to estimate the percentage of the sulphur dioxide in it. Such a study will be of great value in the design of a chimney to minimize the smoke nuisance.

As a matter of fact, it is intended to discharge all the smoke out to sea at the Hitachi mine away from the land, by means of the prevailing air currents. For

this purpose, a great chimney 1000 ft. high (perhaps it will be called the tallest in the world) is making fast progress toward completion. Such a solution of the problem was forced by the imminent damage suits, and the difficulty of the study of smoke control and the scanty opportunity for it.

Sulphur dioxide is easily soluble in water, so that when the gases are scattered in the air by the wind or air current and meet with water vapor (that is, clouds) it forms a dilute solution of sulphurous acid which later falls down to the ground in the shape of rain. Even if they remain in suspension, the dense vapors of H_2SO_3 forms a huge mass of clouds passing to and fro and causing excessive damage to the vegetation. Owing to the famous tobacco-farms around the mine, this nuisance, no doubt, was held most seriously by the farmers. And also it is obvious that these clouds move as the wind blows. Therefore, it is impossible to manage the migration of the gases since all the air currents are not fully known in their details. Especially so in the Hitachi district where not only the rugged forest land but the misty climate makes the current extremely irregular.

From these viewpoints it is evidently necessary to look into all details, because the concentration of the mixture of the gas and vapor is changed with the temperature, time of day, season, weather, altitude and other factors. At the Ashio mine the smoke studies have been prosecuted for several years, but the conditions are quite different from those surrounding the investigations at Hitachi. Ashio's studies have been based upon Cottrell's electric precipitation process. But though it is easily possible to settle all the solid matter and fume containing Cu, Sn, Pb, As, Sb, S and C, the precipitation of SO_2, a true gas. is unfortunately beyond the scope of the process. Therefore, colorless as the smoke becomes, it contains an unchanged percentage of SO_2, and which is freely discharged in the air. This is a weak point of the process. Ashio is now endeavoring to remedy this by developing processes for catching the gas.

This will be a pretty hard matter since there are no available references to similar work in Europe and America. In Ashio's method, the main principle consists of making a harmless substance out of the SO_2 gas, while Hitachi's method only sweeps the smoke from the land and the farmers. If practicable it no doubt will be the better method than the latter.

It is not an impossible matter; since all the solid substances are precipitated by electricity, it is also easily possible to catch the SO_2 after it has been changed in a solid form.

Some years ago an opinion was published on this subject, the idea utilizing limestone. But unfortunately electricity had not then been used for smoke precipitation at the time. A special apparatus is arranged at one part of the flue which leads from the furnace by which water is sprayed into the flue. This water is readily changed into steam by the heat in the flue gases and the SO_2 which passes there immediately reacts with the steam. The mixture is now introduced into a cooling chamber which is either arranged separately from the flue or directly beyond the spray. For example, pair of rooms are partitioned off in the flue, the first of which is filled with crushed pumice and the second with limestone. The first room is cooled to constant temperature and moistened by the water-spray. When the gas passes this chamber the SO_2 and water vapor contained, soon changes into a liquid solution of H_2SO_3 on account of the lower temperature. This solution seems quite concentrated. This can be easily appreciated, although there is no record of its specific gravity, by the extremely quick decomposition of the limestone contained in the next room to the cooling chamber, where the H_2SO_3 water is introduced. There it combines with the $CaCO_3$ and becomes $CaSO_3$, whose properties are neutral and harmless, and it can be thrown away. At least three limestone chambers are required in this case. It is evident that the action of H_2SO_3 in the first chamber is exceedingly rapid, in second somewhat slower, and in third very small. After the SO_2 is expelled the smoke is next discharged by means of a fan after all the dust and fume is settled.

At the time this method was only considered in principle or theory without figuring its cost, or the utilization of the product $CaSO_3$. I believe that this method is not impossible to apply in modern practice if the by-product could be utilized. By this method we can easily effect a clearance of 85 per cent while in the milk lime method (described below) only 70 per cent. The only material required in the process developed at Ashio is the limestone, which can easily be obtained at metallurgical plants.

In a similar process to that above mentioned, SO_2 is mixed with steam and then at the certain part of the flue a limestone powder is jetted into the gas with a strong blast of air. The SO_2 becomes fixed in $CaSO_3$ which may be settled by electricity and finally we have a harmless gas to be discharged from the chimney. As before mentioned, when this process is applied in practice we must consider the treatment of the $CaSO_3$ produced, because, even though this method is suitable theoretically, it is difficult to apply, since so far we have no economical utilization of the product by which we may regain part of the cost of the treatment.

Therefore we finally come to the conclusion that we must plan for the utilization of the calcium sulphite, if this method is to be adopted. A suggestion for this is briefly stated as follows:

Sulfurous acid is the most important material for the paper mill in making paper pulp. But in Japan the demand for the acid is rather small since the paper milling industry is not active at present. We have only one such factory which is in Karafuto and which is so far from any smelter that transportation will be very difficult. We conclude that it is hopeless to supply the acid for paper milling, since the crude product contains $CaSO_3$, CaO, S, Zn, Cu, Sb, Pb and C. This mixture has no present use. If it were necessary to treat it, it might be possible to extract sulphur from it. If that were done, what would be the result? If the SO_2 from all the chimney gases in the plants treating the sulphides in this country were condensed to elementary sulphur, we would produce about 100,000 tons of it in a year. This amount is greater than the total production of sulphur in Japan in a year (that is, 80,000 tons). Or if sulphuric acid would be manufactured, the quantity would be far beyond the consumption of Japanese industry. And if the produced acid could not be sold to consumers, what could be done with it?

As before mentioned, the extracted sulphur is cheap in cost as well as impure, and naturally the price of

manufactured sulphuric acid is low. Consequently almost all the pyrite used in acid plants will be replaced by this by-product sulphur. This condition cannot be called a favorable one in mining economy. Not only would pyrite lose its value but the copper metallurgists also would at the same time have no way to get their clinker.

They would be forced to roast the pyrite themselves, which would be a big undertaking at the present time in Japan. And if it were accomplished, what is the thing discharged from the chimney? SO_2 gas! I fear all the meaning and purposes for adoption of the method is destroyed. That is, on one hand they endeavor to get rid of a gas, and on the other hand they make the gas for the sake of itself. Sulphur is burned into SO_2, and SO_2 reduced again to sulphur. Thus sulphur circulates alternately gas to solid, solid to gas, and I cannot say it is a good practice to circulate the sulphur to no purpose; it is only a waste in cost and apparatus.

Now a word about the utilization of calcium sulfite. We can use the product in agriculture as a fertilizer instead of extracting the sulphur from it. That is to say, we never again liberate the SO_2 from the fixed state.

Then at the right we catch the SO_2 and at the left can change the enemy of the farmer into his friend. A satisfactory solution of this troublous problem which has been open so many years in Japan will doubtless appear in the near future.

Narayama, Akita, Japan.

Japanese Production and Exports of Sulphuric Acid

Since the beginning of the year the price of sulphuric acid in Japan has been steadily advancing owing to increased exports to Russia and China, and also to the Allies for war purposes, according to *Commerce Reports*. As a result, some of the artificial-fertilizer companies have reduced the output of fertilizers and devoted their energies to the manufacture of sulphuric acid, while a number of companies have been established exclusively for the manufacture of the chemical. Its output has accordingly increased in a large measure, and some anxiety is entertained with regard to overproduction after the war. According to latest investigations, the present total output in this country amounts to 582,500 tons a year, excluding the output of a few factories that is not made public. Of this quantity, 421,150 tons is consumed by the manufacturers themselves for the manufacture of sulphate of ammonia, hydrochloric acid, etc., leaving the remaining 161,150 tons available for general requirements. The domestic demands now amount to about 100,000 tons a year, so that the quantity for export is about 60,000 tons. It is taken for granted that on the conclusion of the war the exports will fall off, while it is also very probable that the stoppage of war industries will cause a considerable decline in domestic requirements.

It is estimated that the output of sulphuric acid, if turned out at the present rate, will be in excess of the demand by about 100,000 tons on the resumption of normal conditions after the war has been concluded.

Radio-Activity and Some Advances in Physical Science[1]

By Howard H. Barker

The study of radioactivity has opened up an extensive field of research, which has led to a new conception of our old ideas and given us a better insight into the nature of matter. As a result of Becquerel's discovery in 1896 of the peculiar radiations emitted by all uranium compounds, some thirty new elements have been discovered, which are characterized as being radio-active.

In order to explain the phenomenon of radio-activity, Rutherford and Soddy have advanced the theory which regards the atom of the radio-active element as suffering spontaneous disintegration, and giving rise to a series of radio-active substances which differ in chemical properties from the parent element. That is, the property of radio-activity is a phenomenon which occurs from within the atom, and as far as is known is not affected by any chemical or physical agencies which one can apply from without. To illustrate this property of intra-atomic disintegration, the uranium atom loses a helium atom carrying two units of positive electricity and resulting in the product uranium X_1. This helium atom carrying the two positive charges of electricity, known as the alpha ray, is expelled with a velocity of about one-tenth that of light. Uranium X_1 undergoes a further atomic disintegration with the expulsion of a particle carrying a unit negative charge, known as the electron or beta ray, and producing a new element uranium X_2. The beta rays or negative electrons are expelled with a velocity comparable to that of light and are quite analogous to the cathode rays. The third type of radiation which usually accompanies the beta rays is known as gamma rays and is quite analogous to the X-rays. They consist of ether vibrations of exceedingly short wave lengths.

Perhaps the most striking characteristic of the radio elements is their rate of decay or transmutation. The rate of decay for each element, which has been determined by actual observation rather than atomic weight determinations, due to the fact that radio-activity allows the study of very small quantities of these substances while atomic weight determinations would require relatively large amounts. Uranium, radium, radium emanation, ionium and thorium are the only members of the radio-active family that have been obtained in large enough quantities for atomic weight determinations.

For radio elements of long life such as radium with a "half period," by which we mean the time for one-half of the original amount to disappear, of 1750 years, or uranium whose half decay period is about five thousand million years, more or less indirect methods must be used. The half decay period for these long-lived substances may be ascertained by determining the number of alpha particles emitted from a known weight of a substance in a definite time. Since a gram atom of an element contains 6×10^{23} atoms, it is an easy matter to calculate the fraction of the number of atoms present decaying per second, each alpha ray representing one atom of radio-active matter undergoing transmutation.

In this connection it is perfectly correct to say that

[1] Paper read before The Teknik Club, Denver, Colo.

we are counting the number of atoms or molecules in a given substance with just as much accuracy as we count the inhabitants of a city. No census is correct to more than one or two parts in a thousand and this represents about the degree of accuracy with which we are able to actually count the number of atoms or alpha particles. An interesting simile was given in an address by Sir J. J. Thompson to show the great advantage of detecting electrified bodies over unelectrified bodies. Professor Strutt, by means of the spectroscope, was able to detect the neon in 1/20 cm^3 of air. Ramsay established that only 1/100,000 part of the air is neon, therefore the neon in 1/20 cm^3 would occupy 1/2,000,000 of cm^3 at S. T. P. In this small volume there are about ten million million molecules. The population of the earth is established at about fifteen hundred million, so that the smallest number of molecules of neon we can identify is about 7000 times the population of the earth. In other words, if we had no better test for the existence for a man than we have for an unelectrified body of molecules, we should come to the conclusion that the earth is uninhabited. If the alpha particle had been uncharged, we should require more than a million mollion of them instead of one before we would have been able to detect them.

For the radio-elements of comparatively short half-period, such as radium emanation with a half period of 3.85 days, the electroscope may be readily used in determining the period of decay.

Now let us consider for a few moments a little more in detail these various types of radiations and their peculiarities. The alpha rays in their passage through matter cause ionization and thus render air a conductor of electricity and so discharges electroscopes, thus giving the basis for radium and radio-active measurements. They also affect photographic plates and produce phosphorescence in certain substances, for example, Sidot's blend or phosphorescent zinc sulphide. This phosphorescent effect analyzed has been shown to consist of individual flashes of light.

Sir Wm. Crookes has devised a simple apparatus known as the spinthariscope for observing the scintillations due to radio-active matter. It consists of a trace of radium concentrated at a point and placed several mm. away from a zinc sulphide screen, which is fixed at one end of a short tube, and viewed through a lens at the other end. One then sees hundreds of scintillations, each one of which is due to the bombardment of an alpha particle against the zinc sulphide screen, thus indicating the transmutation of an atom of radium at the point. The rays are slightly deviated in a strong magnetic field at right angles to their path. The alpha rays from different radio-active substances have different velocities of expulsion and ionize the air for different distances. The rays are readily absorbed by thin sheets of paper or metal foil or a few centimeters of air due to the large mass of the particle and to its low velocity. Upon stopping the alpha particles their extra energy is converted into heat. One gram of radium has been found to produce 134 cal. of heat per hour, of which 124 cal. are due to the alpha particle. From these figures it has been calculated that the disintegration of one gram of radium and its disintegration products develops at least 400,000 times as much heat as can be obtained by burning one gram of carbon, or a simple calculation will show that one pound of radium has inherent within its atoms the heat energy equivalent to 400,000 pounds or 200 tons of coal. One ounce of radium in its complete transformation to the end products will give off enough energy to lift 5,000,000 tons through a distance of thirty feet. In other words; one ounce of radium will give off enough energy to lift one hundred of the largest battleships afloat entirely out of the water.

The beta type of radiations from radio-active substances are more penetrating than the alpha rays due to the relatively small mass, about 1/1700 the mass of the hydrogen atom, and the comparatively large velocity. Beta rays are more readily deflected by a magnetic field than the alpha rays. The ionization effect of the beta rays are about 1/100 that of the alpha rays over the same distance.

Gamma rays never appear independently of the beta rays and are probably produced by the beta rays just as the X-rays are produced by the cathode rays. They are not deflected by a magnetic field. They are very penetrating as is shown by the fact that they will pass through the human body or through one foot of iron, but their ionization effect is only about 1/10,000 that of the alpha rays.

The beta and gamma rays as well as the alpha rays are capable of producing phosphorescent effects on certain minerals, but not to the extent that the alpha rays are, while the gamma rays are even less intensive in their effect than either of the other two.

The beta and gamma rays are finding a very valuable use in the treatment of many malignant growths such as cancer, and it has been for this reason that radium has a commercial value. Lately the use of radium mixed with phosphorescent zinc sulphide for the production of permanently luminous preparations has become of commercial importance. This material is used on the dials of watches, compasses, etc., to render them visible in the dark.

The chemistry of the radio-elements and the work on the constitution of the atom which has grown out of the study of the radio-elements and their rays presents a far more interesting field than the technology of radium, particularly since the various phases of treatment of radium ore cannot be detailed minutely. One of the most powerful methods of obtaining information on the internal structure of the atom lies in the study of the scattering of the high speed particles; for example, the alpha and beta particles in their passage through matter.

Sir J. J. Thompson in assuming that the atom consists of a positive sphere of electrification, in which moved the "corpuscles" or electrons was able to account for many of the properties of matter, both material and electrical. Rutherford assumes this positive electrification concentrated at the center and is very small compared to the total space occupied by the atom. This theory was advanced to explain the scattering or deviation of alpha rays from their paths in passing through matter, the assumption being that the very sharp bends in the path of the alpha ray indicate an approach of the alpha ray to the nucleus, causing the deviation.

In this connection we can say that the head-on collision of an alpha particle with a hydrogen atom re-

sults in the nucleus of the latter being projected beyond the range of the alpha particle. By experiment Marsden found that the hydrogen nucleii produced scintillations on a zinc sulphide screen at a range of about four times as great as the particle. Some mathematical investigations by G. C. Darwin indicate that the alpha particle and the hydrogen nucleus must have approached so close that the centers were about 1.7×10^{-13} cm. apart. This result affords evidence of the extreme minuteness of the nucleus as compared with the size of the atom 1×10^{-8} cm.

Correlated with this is the interesting result of Barkla, obtained some years earlier, who showed from the scattering of Röntgen rays that the number of electrons in the atom must be about ½A, where A is the atomic weight. As is well known, the mass of the negative electron is about 1/1700 the mass of the hydrogen atom, so that the bulk of the mass of the atom must reside in the nucleus, and this is accounted for on the basis of the electro-magnetic mass by the fact that the nucleus is so much smaller than that of the negative electron. Thus we see that the atom is a miniature solar system, the sun is represented by the positive charge nucleus, which constitutes the main mass of the atom, the planets by one or more rings of electrons revolving rapidly around the nucleus giving rise to the chemical properties and visible spectrum depending on the number and arrangement of these outer electrons. The gravitational force is replaced by the electrical attraction between the positive nucleus and the negative electrons.

It was thought, though without experimental evidence that the X-rays and the gamma rays were of the nature of ether pulses. Their extreme short wave lengths made measurements impossible until it occurred to Laue that the atoms in a crystal might serve as a grating for the defraction of these rays, when their nature was definitely proven. Mosely applied this idea with marked success to the determination of the nuclear charges of the atoms of most of the elements. It might be well to state that there can be excited by the elements definite vibrations of short wave length which we call X-rays, and a simple relation has been observed between the frequencies of these X-ray vibrations of the elements and the elements when they are set in the order of their increasing atomic weights. Mosely bombarded the elements one after the other by electrons as cathode rays and reflected the resulting Röntgen rays from a crystal, and measured the wave lengths of one or other of the principal radiations. In this manner he was able to determine the so-called atomic numbers of all the known elements from aluminium 13 to gold 79. These experiments bear out well a view first propounded by Van der Brock that each element has an atomic number, an integer representing its place in the periodic table (H1, He2, Li3, etc.). The atomic weight is not an exact integer nor of such fundamental character as the atomic number.

Rutherford has extended Mosely's methods and results to crystal reflections of gamma rays from RaB and determined the wave lengths of many lines, in particular of the two strongest. He has bombarded Pb with RaB rays and found the lengths of the radiations stimulated in the lead. He found that RaB and lead gave the same spectrums, indicating that they have the same atomic or ionic number—82. Hence, he deduced all of the atomic numbers of the elements in the uranium radium series.

All of these results are in harmony with the wonderful advances in radio-chemistry, due to Soddy, Fajans, Von Hevesy and others, that the expulsion of an alpha particle lowers the atomic number and valence by two, the atomic weight by four, and a beta ray change increases the atomic number by one and likewise the valence without change of atomic weight.

In accordance with this theory the end products in the disintegration of the uranium and thorium series are two new elements identical in *chemical* properties with ordinary lead, but whose atomic weights differ from that of ordinary lead by at least one unit each. In other words, three species of lead exist having atomic weights of 206.2 for the end product of thorium; 207.2 for ordinary lead and 208.2 for the end product of the uranium series of disintegration. These different kinds of lead are non-separable by chemical methods. They have identical spectra and chemical properties, but their atomic weights differ considerably more than those of cobalt and nickel. Hence the atomic weight loses some of its significance as a fundamental constant of nature. By what concept is it replaced? The answer is the *atomic-number*. From the structure of the atoms, those elements displaying similarity of spectra, valence and chemical properties, but the constitution of whose nucleii are different, are known as Isotopes and have the same atomic numbers.

Perhaps a more striking example of the chemical identity of elements of different atomic weights is afforded by the elements lead and RaB already alluded to. The atomic weights of these two elements differ by seven units. These elements, like the other isotopes, have different nuclear masses, but have the same nuclear charges and therefore the same number and arrangement of the electrons in the outer rings.

In this brief and scattered survey I have endeavored to make the following points:

1. That the phenomena of radio-activity, in contrast to chemical changes, represents processes occurring within the atom itself; that is, radio-activity is an intra-atomic property—an exhibition of atomic disintegration.

2. The disintegration is accompanied by the liberation of an extraordinary amount of energy in comparison with known chemical changes. Radio-activity has thus revealed a store of energy whose existence had hitherto not been dreamed of.

3. The key for the control of the rate of liberation of this energy, *i.e.*, rate of transformation of the radio-elements has not as yet been found.

4. One of the resulting atoms in many of the atomic disintegrations is the alpha particle, a charged atom of helium. Thus we are face to face with the close relationship of matter and electricity.

5. The present-day view of the structure of the atom, based upon the electrical nature of matter, affords an explanation of the new knowledge and in particular (1) the scattering of rays from radio-elements in their passage through matter; (2) the identity of the spectra and chemical properties of certain elements of different atomic weights which marks the introduction of a more fundamental constant of nature than the atomic weight, namely, the atomic number.

Denver, Colo.

Hazards of Low Voltage Mill Machinery

At the recent meeting of the National Safety Council particular stress was laid by many speakers of the present national necessity of a more intensified "safety first" campaign. Numbers of papers of interest to all engineers were read; among them, the following (slightly abstracted) was presented by Dr. C. A. Lauffer of the Westinghouse Electric & Manufacturing Co., before one of the meetings of the Iron and Steel Section. It is of interest to all engineers who have to do with the installation and operation of mill motors and low voltage circuits, so common in metallurgical and chemical plants.

* * * *

With reference to hazard, there is no such thing as low voltage. All circuits are dangerous to a degree; 500 V., D. C., is low voltage, but is very dangerous, both as to electric burns and shock; 110 V., A. C., is not likely to burn, the initial arcing has low intensity, but on a heavily fused circuit, under certain conditions, 110 V. may produce burns, and sometimes causes fatal shock.

In this paper, however, the term low voltage will apply to circuits of 600 volts and under.

Electric Codes

The Electric Code of the National Board of Fire Underwriters, relating to the construction and installation of electrical apparatus to reduce the fire hazard, applies also to reduce the electric shock and burn hazard.

The National Electric Safety Code is a noteworthy contribution to the cause of Safety First in the whole electric field. This electric code is receiving nation-wide recognition; a few state commissions have already adopted it, or part of it; a number are considering its adoption.

At the point of utilization, where the circuit is handled by non-electrical people, the isolation and insulation of the current carrying parts should receive particular attention. Precautions essential for the protection of the consumer of current would be irksome if required in generating stations, and in mills and factories, where skilled and experienced men only have access to the circuits and switchboards. The continuous requirements for alterations and repairs in mills and factories make it very inconvenient to have low-voltage circuits totally inclosed. It is contended that removing the casings from the inclosed conductors retards and prolongs alteration and repair operations without eliminating the electric hazard.

There is hazard in every industry; elevators and cranes, steam piping and boiler applications, coal mining, the chemical and explosive industries, and other pursuits, relative to the number of employees and exposed persons, are more hazardous than the electrical industry and electric applications, in the light of present developments.

Electric energy has become the most potent factor in doing the world's work. Like every other form of harnessed energy, however, it must be confined within its proper channels.

Fire and water, compressed air and steam, drugs and chemicals, likewise are safe only when confined and intelligently employed.

Current, however, can, and always should be, as safe to the consumer as gas and water now are.

Electric Shock vs. Electric Burns

The two types of electrical injuries encountered in the industries are electric shock and electric burns.

In electric shock, the patient becomes a part of the circuit, the current being transmitted through his body. The internal path of the electric current through the patient's body may become established without visible burning or with a mere puncture burn.

In electric burns, the patient's body comes in too close proximity to an electric arc. Such electric burns are the result of heat energy—they are thermoelectric burns. Other burns, as arise from arcing and electric welding, of which "flashed eyes" is a type, are due to the actinic rays of the electric arc, the patient being too remote to experience thermic burns.

In the case of short circuits, where the patient's body is interposed between the two lines, or between one side and ground, the patient's body then completes the circuit. There may be an imperfect contact, in which case an arcing distance intervenes; if hand to hand, both hands may be burned; if hand to foot, then burns may be found on both extremities, those on the feet often following the nails of the shoes.

When the circuit thus becomes completed through the patient's body with an intervening arcing space, both electric shock and burns may ensue. The human body, serving in this manner as a short circuiting medium, completes the circuit; the amount of current transmitted depends on the electric resistance of the body and the nature of the contact. The greater the intervening arc, or arcs, the less current there is available to penetrate the body. Since the human body is in series with the arc, produced by poor contact, a considerable voltage (or pressure) drop may occur in the arc, or arcs—the body, accordingly, being subjected to a relatively moderate shock. It is this fact that makes efforts at resuscitation so successful in the vast majority of cases.

While electric shock and burns are usually associated, they are thus seen to be essentially different. Persons without discoverable electric burns may indeed be fatally injured, and, conversely, persons frightfully burned may suffer less from electric shock, because, as results of the electric arcing, there is a considerable voltage drop in the arc, as just related, and because the coagulation necrosis, and charring of the burned tissues, apparently, block the flow of the current through the patient's body.

Other trauma may be associated with electric shock and burns. A slight shock, producing fright, or muscular recoil, may cause a patient to fall from an elevation, or he may sidestep into revolving machinery, and the injuries from the latter causes may be more grave than those arising from the electric circuit.

The skin resistance of the human body is relatively high, measuring approximately 4,000 ohms. The dry calloused palms of a workingman afford a much higher electrical resistance. No accurate figures can be given, as different individuals vary in their response to electric currents, and the readings for the same individual will show variations.*

*The various external and individual circumstances that influence the extent of electrical injury, in the grouping of Dr. S. Jellinek, are: "1. External: (*a*) voltage, (*b*) amperes, (*c*) number of cycles, (*d*) points of contact, (*e*) time limit of contact, (*f*) the kind of current (A. C. or D. C.). 2. Individual: (*a*) resistance of skin and body, (*b*) the path of the current through the body, or over the surface of the skin, (*c*) the condition of the mind and body."

The accurately measured electrical resistance of hand-to-hand contact, obtained by the bridge method, expressed in equivalent ohms, dry surfaces, 6 in. tin-foil contact, gives a minimum of 40,000 ohms, maximum of 140,000.†

The definite amount of electric current that may pass through the human body without danger to life has not been experimentally determined. The accidental electric contact injuries do not permit of the measurement of the amperage.

It is conceded, however, that one-tenth ampere of current passing through the body may become dangerous, one-fourth ampere may prove fatal, though seven to ten amperes are registered on the ammeter in criminal electrocutions.

It is thus apparent that the relatively high skin resistance of the human body is the element of safety in handling low-voltage lines. A moist skin, however, reduces the skin resistance.

Certain high-frequency currents are relatively safe because the current is confined to the surface of the skin. Low-frequency commercial currents, however, are prone to take an internal path.

When the skin resistance is broken, the current takes an internal path; a dangerous volume of current may then pass through the body, even at relatively low pressure. A momentary contact may result in no damage, yet the same contact, if prolonged, may result in serious injury.

High Amperage on Low Voltage Circuits

The increased hazard of high amperage circuits of low voltage arises from the high-generated capacity of the circuit. Contact with the high-voltage side of an induction coil involves no serious danger, due to the fact that the capacity of the coil is insufficient to maintain its high voltage when delivering current through the body; the induction coil may develop 5000 V., but does not sustain it. Contact with a low-voltage conductor, on a generating system developing several thousand kilowatts, however, releases an amount of energy that is relatively unlimited. The resistance of a high-amperage circuit must necessarily be low, and does not to the same extent tend to retard the flow of energy. When more energy is released the potential hazard is augmented.

The danger in a low-voltage circuit of high amperage capacity is evoked by interrupting the circuit, and is manifested by fire and flame. Such arcing may cause flash burns. Interrupting a circuit of great capacity feeds more energy into the arc, and may vaporize metal in its initial arcing; this vaporized metal, by reducing the resistance of the arcing path, may establish a dangerous arc. Low voltage does not sustain an arc, however, as does high voltage.

The hazard from "grounds," on low-voltage circuits of high amperage, accidentally grounded, however, is but slightly greater, that being a question of voltage rather than of amperage.

Some Injuries Inevitable

The Safety First campaign has achieved better methods of handling electric circuits, and has resulted in perfected mechanical devices for reducing the electric hazard. Human nature, however, "is prone to err, as the sparks to fly upward." Miscellaneous inadvertencies will arise, as operatives will forget which line is alive; or they may become so familiar with live circuits that familiarity makes them careless; switches will be opened when lines are loaded, testers make wrong connections; and through lack of attention, in various ways, some electric injuries seem inevitable. The human equation alone resists analysis, in the more complete elimination of industrial accidents, and even this, to some extent, can be regulated.

Safe Men

Systematic physical examination of prospective employees results in: (*a*) The *selection* of keen, qualified men, mentally alert and physically fit, for those posts in industry requiring such qualifications; (*b*) the *elimination* from industry of those unfit for any work in that industry; (*c*) the *adaptation* of the physically defective to posts in industry where their existing defects do not disqualify them from employment; (*d*) the *restoration* of others to industry by correcting existing defects—such as lenses to correct defective vision; dental work; surgical operations, for hernia, varicocele, hemorrhoids, etc.

The industrial physician will recommend that men with tubercular lesions and organic heart disease be not placed where they handle live circuits, but be located in some less hazardous employment where their existing defects militate less against them. The medical inspection of employees is thus a safety factor, approved of by employee and the management alike as a justifiable means of reducing the accident hazard. Only qualified men should handle electric circuits or work in proximity thereto.

Prudence

"Handle every line as if it carried 10,000 V.," is the attitude displayed by qualified electrical experts. Regard the line as "hot," unless it is positively known to be otherwise. You cannot tell when the line may become charged. Energizing a circuit on which men are making repairs and adjusting apparatus is a prolific source of hazard; hence, the need of locking switches, grounding lines, and appointing leaders in operations on live circuits and those potentially alive. Such Safety First instruction to men working on low voltages will measurably minimize the hazards associated with low-voltage systems.

Ignorance accounts for few electric injuries, carelessness for few; thoughtlessness is probably responsible for a larger portion of them.

Jumping

The jumping distance of 500 volts is one-fiftieth of an inch, which justifies the conclusion that the jumping distance of low-voltage is negligible as an electric hazard.

Contrasting with high voltage, 20,000 V. will jump

†Quoted in "Electrical Injuries," by C. A. Lauffer, M.D., John Wiley & Sons, publishers. From "Experiments of H. E. Heath," Consulting Engineer, Baker Electric Company, New York City.

	Minimum, Ohms	Maximum, Ohms
Forehead to neck (back)	3,400	4,000
Neck (back to chest)	5,300	7,500
Neck to right hand	14,000	60,000
Neck to left hand	26,800	55,000
Neck to both hands	10,850	35,000
Neck to hip	18,500	80,000
Neck to knee	120,000	170,000
Hand to hand	40,000	140,000
Hip to knee	47,000	165,000

an inch between needle points, 60,000 V. will jump 5 in. between needle points—there is a relative safety in low voltage, as regards jumping from conductors. High-voltage lines are placed high out of reach, danger signs are employed for high voltage, and in consequence of this known jumping distance, no dependence is placed on insulation; all lines are made "dead" when repair operations* are in progress. Such precautions rob high voltage of its dangers.

Reliance on Insulation

In consequence of the low-voltage jump being one-fiftieth of an inch or less, excessive reliance may be placed on the insulation of conductors. Excessive confidence in insulation, trusting in insulation for immunity against electric shock and burns, increases the low-voltage hazard. Live low-voltage conductors are handled indiscriminately in homes and factories, with the result that defects in insulation constitute a perpetual hazard to the electric consumer.

Insulation gets old and decays. Old rubber becomes brittle and breaks, exposing the conductors. Conductors exposed to wear and friction lose their insulation, and, at the thin points in the insulation, the persons handling the conductors, especially if grounded when the contact is made, may experience a shock or burn.

Attention to the renewing of service wires and leads is essential to safety from leaks through defective insulation. In good shop practice, lines and leads are inspected and measured periodically, and renewals made where defects exist, or carrying capacity so requires, thus insuring against possibilities of grounding and defects in insulation.

Dust and Dirt

While the jumping distance of low-voltage constitutes no hazard, ordinarily, a damp or dusty path may contribute to the rupture of the air resistance, permitting arcing to occur at a greater distance. Particularly when the dirt consists of iron filings or other metallic waste, and there is simultaneously defective insulation, can this increased arcing occur. After the arcing is once established it can draw off an increasing amount of current; hence, combinations of conditions can arise in which the low-voltage hazard is increased.

Flashing Commutators

Cleanliness is necessary as a safety factor in handling motors, as well as other electric apparatus and equipment. Dirt and dust accumulating on the commutator may cause it to arc over; in shop phraseology, "the commutator flashes over." The flash is from brushes to bars, or across the whole surface of the commutator.

Such arcing causes flash burns of the skin, if anybody chances to be near at the time; the actinic rays of such an electric arc, like in welding, may even cause "flashed eyes" among persons beyond the range of the heat of the arc.

Other reasons may account for commutators flashing over, such as excessive speed or load, the type of motor, and short circuits on the line, yet dirt is the commonest cause of this form of electric hazard.

If the motors are attended by practical men, and the brushes and commutators kept clean, such arcing is avoided. Conducting particles worn off the bars and brushes may short circuit the bars, unless they are kept clean.

Breaking Circuits

Starting switches for industrial motors, both for group drive, and for individual drive, require complete protection. A study of this type of hazard has developed many styles of covered switches and control apparatus which prevent the operator coming in contact with live parts. Knife switches with handle outside, so constructed that everything inside the box is dead as soon as the box is opened, is one solution of the problem of safe circuit breaking on low-voltage systems. The key is in the possession of the authorized person, who has ready facilities for access; the unauthorized person is thus kept away. Replacing fuses, or other repairs within the switchbox, present no electric hazard, as opening the box automatically breaks the circuit.

A slowly opened switch, on a low-voltage line of high amperage flow, will draw a heavy arc. Quick operating breakers of proper design are employed, therefore, to avoid flash injuries. Arcs are also broken under oil in certain types of switches.

The flash hazard, incident to opening switches on heavily loaded circuits, is also successfully solved by employing remote control; switches for high voltage are operated electromagnetically, from any desired distance, by utilizing an auxiliary switch operated on 110 V. and above.

Low voltage circuit breaking is dangerous, but it carries no insurmountable electric hazard, when the best modern equipment is used and qualified men, properly schooled in safety methods, are employed.

Short Circuits

Short circuits arise (*a*) when circuits of different voltages and different polarity are thrown together, (*b*) through the breakdown of insulation on lines, motors, generators, etc., (*c*) when a metallic conductor of relatively low resistance is placed across terminals, or conducting elements, differing in potential.

The personal element enters largely into this phase of electric hazard; bare lines are allowed to touch; a screw driver slips and goes across a bus bar; pliers, or other tools, inadvertently cross the two lines.

The intensity of "short circuits" will depend on the size of the units that are connected to that line, and the setting of the protective devices, as fuses, relays, circuit breakers. "Shorts" have a tendency to blow fuses.

A backed-up induced current may also increase the intensity of a short circuit. Thus, a large generator will be feeding a motor, or series of motors; its lines will become crossed—a cross inside of the load may feed the power of the generator into the "short circuit," and also back up the load (induced current) from the motor.

Grounds

Electric generator and motor frames are grounded, but both the outgoing and the incoming lines are insulated from ground, unless, as stated, the circuit is employed for railway purposes.

Should any portion of such circuit become grounded, however, then contact with the opposite line, and at the same time with ground, would involve precisely the

*Repair operations on live circuits up to 40,000 volts are conducted, elaborate insulation being provided for the protection of the repairmen. It is desperate practice, however, too hazardous to commend.

same electric hazard as touching ground and the trolley wire on trolley systems employing ground.

In low-voltage systems, nevertheless, either side of the line may be repaired, if the line being repaired is purposely grounded, providing contact with both sides at the same time is avoided, and providing, moreover, that there are absolutely no abnormal line conditions.

In handling any circuit, therefore, the only safe procedure is to assume that it is grounded; but as a precaution obtain the volt meter readings from line to ground to make sure that this assumption is correct. If one side of the circuit is already grounded, intentionally or unintentionally, grounding the other side produces a short circuit. If the body makes a better ground than the ground already existing there is hazard involved. If one side of the circuit is properly grounded, it is safe to work on that side—bearing in mind that the other side is "hot." Place additional ground on the line. In grounding a line, employ a big cable, not a thin wire; it is good practice for the workman to protect himself with a thick cable, or a chain, in grounding his line, as the protection might be lost through a thin wire burning off.

Standing on dry wood, or some other insulating material, is a precautionary measure, in dealing with live low-voltage circuits; the repairs in every case must be completed on one side of the line at a time, as handling both sides of the line simultaneously causes short circuits.

Insulating the body is not a safe practice in handling live high-voltage circuits, as the insulated body has a potential of its own, and this difference of potential is an electric hazard. The man working on a low-voltage line, or up to 2200 volts, is absolutely safe if the line is grounded and he is on ground. Place the man on insulated material, however, and there then exists a difference of potential between the man and the line grounded.

Transformer Breakdowns

This hazard from transformers is reduced by careful tests, conducted by manufacturers, before transformers are marketed; during a lightning storm, however, a transformer's insulation may be burned out, permitting the high-tension primary to impose its voltage on the low-tension secondary.

The precaution mentioned earlier in the paper will bear repetition. It is best to work on dead lines, but if compelled to work on live ones one should assume that every live line may carry high voltage.

A line assumed to be low voltage may actually be higher voltage, through the accidental crossing of lines —as when falling trees or electric storms cause high-voltage lines to come in contact with those of low voltage. A telephone wire and trolley line, crossing is a familiar instance of such possibilities.

Repairing Live Wires and Switchboards

(1) Avoid personal contact with both sides of the circuit at the same time. By handling just one lead at a time, what is necessary on that side may be finished before the other side is touched.

(2) Avoid "shorts"—do not allow wires or tools to make contact with both sides of a circuit at once.

(3) Operators on low voltage may be insulated from ground by standing on dry wood or other non-conductors to insure safety; or, should that side of the circuit be intentionally grounded, repairmen should be also grounded.

(4) The leader should be made responsible for the control of switches and grounding.

(5) Only qualified men should make alterations and repairs at switchboards or handle switches.

Breaking the Contact

Accidental electric contacts should be immediately broken. As the flexor muscles are more powerful than the extensor muscles, the individual who grasps an electric conductor of low voltage may not be able to release his grip.

It reduces the electric hazard, therefore, to have men work in pairs, or in gangs, so that no workman, encountering electric current, be isolated from his comrades.

Safety First instructions, varying with the sphere of service, must include methods of instantly breaking the electric contact (*a*) by opening switches, (*b*) cutting the line, (*c*) grasping patient by his dry clothing and pulling him bodily away, (*d*) removing the conductor from him by means of dry wood, dry clothing, or rubber. As the hazard from electric shock and burns is proportionate to the duration of the contact, methods must be devised in anticipation of such emergencies to expeditiously meet them.

Caution is essential for the rescuing party—cutting a conductor, for instance, might prove hazardous. All methods devised for breaking the contact, therefore, must be relative to conditions encountered, and must embody absolute safety for the rescuer.

Treatmeent of Electric Burns

The limited time allotted me and the scope of my subject permits no prolonged consideration of electric injuries, aside from electric shock.

Electric contact burns. These burns, though deep, are frequently painless, owing to the destruction of the sensory nerves and the anesthetic characterists of electric current. The slough is slow in separating in deep and extensive contact burns; the lines of demarcation that arise will indicate the extent of tissue loss that will ensue.

"Flashed Eyes"

The congestion, lachrymation, and photophobia of "flashed eyes" is best treated by cold compresses for an hour in the works dispensary before sending the patient home with instructions to stay in a darkened room, using ice cold compresses, but not ice, alternate hours, and wear smoke-lensed spectacles until the sensitiveness to light subsides.

If the flash has been near ,the thermit element may enter; the cornea may be coagulated, temporarily impairing the vision, until the separation of the opaque layer of the cornea. In milder cases, with superficial coagulation of the cornea, the irrigation of the conjunctival sac with sterile boric solution and the brushing of the dust and tissue debris from the conjunctival sac with cotton mops will remove the opaque layer of the cornea at once. While cold compresses and exclusion of light suffice for the mild cases of flashed eyes the more severe cases require atropine to allay ciliary irritation, and those still more severe, involving burns of the cornea, demand expert attention, preferably in a

hospital. Cases involving cornea burns, especially, must be kept clean and covered to insure satisfactory recoveries.

After the rather extensive observation and treatment of this species of eye injuries, I can recall no case where bona fide permanent impairment of vision, either as to corneal scars or optic neuritis, arose from "flashed eyes."

"FLASHED SKIN"

Thermoelectric burns arise, if the patient is near, actinic ray burns may develop if the exposure is more remote. They are, prevailing, burns of the first and second degree. Our treatment is not to open blisters at once, but wash cautiously, carefully removing grease and grime with cotton mops, employing gasoline and ethereal soap.*

The careless washing of such burns by unskilled persons may serve to introduce infection; yet in our opinion the flash does not sterilize the wound; the contiguous parts must first be washed, then finally the wound, using many changes of cotton mops, not using mops on the burn that have touched other surfaces.

Employing unguentine on these burns, as soon as they are washed, controls the pain. Dressings do not adhere when ointments are employed, hence the cautious use of certain ointments facilitates redressings as well as promotes recoveries.

"Flash" burns heal up promptly without leaving scars. The extensive loss of the outer skin is alarming, but not dangerous; the great blebs, the water contained acting as cushions, promote recovery, and should not be opened before they become uncomfortable to the patient.

Sulphuric Acid in 1916

Geological Survey Report Issued

The production of sulphuric acid in 1916, expressed in terms of acid of 50 deg. B., was 5,642,112 short tons, valued at $62,707,369, or over 1,000,000 tons more than the Survey's estimate given in our Feb. 1 issue, page 174. To this must be added 443,332 short tons of acid of strengths higher than 66 deg. B., not convertible into acid of 50 deg. B., valued at $10,806,757. The total value of all the sulphuric acid was therefore $73,514,126. This total includes by-product acid—that

LONG TONS OF ORE USED IN THE MANUFACTURE OF SULPHURIC ACID IN 1916

	Sulphur	Pyrite and Pyrrhotite	Gold and Silver Bearing Pyrite	Copper Bearing Sulphides	Zinc Bearing Sulphide
Domestic	261,574	324,602	1,673	568,116	531,625
Foreign	10,903	1,154,550	0	196,404	92,002
	272,477	1,479,152	1,673	764,520	623,627

is, acid produced at copper and zinc smelters. The production of acid from this source in 1916, expressed in terms of 60 deg. acid, was 1,069,589 short tons, valued at $12,158,266, to which must be added 92,802 short tons of acid of strengths higher than 66 deg. B., not convertible into acid of 60 deg. B., valued at $1,941,661.

About 700 tons of acid, valued at about $21,000, was imported; practically all of this was received from Canada. No sulphuric acid was exported by this country.

In the column headed "Pyrite and pyrrhotite" are tabulated all the sulphide ores used which are not treated further for their copper, lead, zinc, gold or silver content. Much of this material doubtless contains small amounts of these other metals, but inasmuch as they are not recovered their presence in the ore is of no economic importance.

Synopsis of Recent Metallurgical and Chemical Literature

Coking

Low Temperature Coking of Inferior Coals.—In the Journal of the Society of Chemical Industry for Aug. 31, 1917, T. F. WINMILL, research chemist of the Staveley Coal & Iron Company, Ltd., England, presents the results of experiments on the low temperature distillation of certain low-grade coals heretofore considered as waste.

Accompanying the main coal seams in some parts of England are often found seams of inferior coal substances, which with different composition and in different districts receive different names, such as "Jacks," "Branch Coal," "Bastard Cannel." As the last name implies, these coals have often some resemblance to a cannel coal, but this resemblance is not very close. They are all distinguished by their high ash content, and the very voluminous nature of the ash, making them useless for ordinary fuel purposes. Jacks and black shale may leave 80 per cent of ash when burnt, while a very good sample of bastard cannel may leave only 10 per cent. Where they occur, considerable quantities of these coals have to be raised with the main coal, and form an expensive waste product, not only from the cost of raising, but because waste tips must be provided on the surface, forming unsightly heaps which often fire either spontaneously or from other causes.

In some districts the bastard cannel is fairly uniform in composition over a wide area and contains generally between 20 to 30 per cent of ash. The associated carbonaceous matter is intermediate in composition between a "soft" coal and a cannel, as is shown by the following limiting analyses, calculated on a dry, ash-free basis:

Carbon	78.0 to 81.0 per cent
Hydrogen	5.7 to 6.0 per cent
Nitrogen	1.2 to 1.5 per cent
Sulphur	1.5 to 5.0 per cent
Oxygen	10.0 to 10.5 per cent

From these figures it is clear that the substance contains a large amount of potential energy which is at present wasted. The carbonaceous portion is comparable in composition to that of a good coal, so that in effect every 100 tons of branch or bastard cannel coal contains as much heat value as 70 to 80 tons of high-grade coal.

Experiments have been made therefore to see whether any portion of this potential energy can be made available in the form of oil fuel or other valuable products. In designing the apparatus, it had to be borne in mind

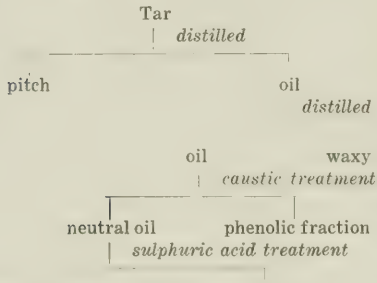
*A good formula for etheral soap, that dissolves and removes the dirt and grime and at the same time renders the area antiseptic, consists of:

Sulphuric ether	(oz.) 4
Turpentine	(oz.) 1
Alcohol	(pts.) 3
Surgical soft soap	(lbs.) 4
Water, enough to make	(gal.) 1

that the coke residuum would in any case be valueless as its ash content would be above 50 per cent. Rapid coking with the biggest possible yield of by-products was therefore the main requirement. The retort was made of cast iron, 2 in. thick, built into a firebrick chamber, and heated by five evenly placed Bunsen burners. It held a charge of 800 lb. of coal and was fitted with a very efficient stirrer working through a vacuum-tight stuffing box. The stirrer quickly ground up the charge and brought fresh portions of it continually against the hot walls of the retort, thus securing a rapid heating throughout the mass, instead of depending on the slow conduction of heat usual in any other coking oven. The distillation was carried out under a vacuum of from 26 to 28 in. of mercury, and had gone as far as it would at 500 deg. C. in three and one-half hours, after which the contents of the retort could be discharged by opening the bottom door and reversing the direction of revolution of the stirrer.

The distillation produced (1) tar and aqueous liquor condensed *in vacuo;* (2) gas which passed through the vacuum pump and was in part burnt under the retort.

The "working up" of the vacuum tar followed therefore the following plan:



The quantitative results per ton of coal distilled were:

Pitch	100 lb.
Semi-solid wax	50 lb.
Soda-soluble oil	4 gal.
Phenolic ethers, extracted by sulphuric acid	1.5 gal.
Hydrocarbon oil	6.5 gal.

The bulk of the ammonia formed was contained in the condensed aqueous liquor, and was equivalent to about 25 lb. of ammonium sulphate per ton of coal. A further quantity of 10 to 15 lb. can be extracted from the gas leaving the condensers, giving a total yield of about 35 to 40 lb. of ammonium sulphate per ton of coal.

The gas coming from the condensers is very similar in composition to ordinary coal gas, and contains very little extractable light oil. Some oil is carried mechanically with the gas, but no appreciable quantity of oil boiling below 150 deg. C. could be obtained, either by condensation or by washing. About 6000 cu. ft. of gas was produced per ton of coal distilled.

The experiments showed definitely that low-temperature distillation of a high-ash waste coal is not a commercially economical process. The initial low cost of the waste coal would at first sight seem to make it possible to work on comparatively small yields of by-products. It must not be forgotten, however, that in ordinary coking practice the price obtained for the coke made, as a rule, more than pays for the slack from which it is made, and hence in the absence of coke from the waste fuels the apparent advantage of worthless coals more than disappears, and the whole costs of the process have to be defrayed by the increased value of the by-products. In previously published accounts the quantity and nature of these products claimed have been sufficient to pay for the process, but in the light of the experiments now described it would appear that these have been estimated too optimistically. The salable products amount to 6 gal. of oil, 35 to 40 lb. of ammonium sulphate, and perhaps 2000 to 3000 cu. ft. of gas after allowing for that necessary for the distillation.

The value of the oil is difficult to estimate, as it is of a new type. It would seem to have little value except as a fuel oil, and for that purpose need not perhaps be so highly purified. Unless fairly complete purification is made, however, the oil will resinify and become of much less utility. The cost of complete purification is considerable. The phenolic substances which it is desired to remove are not very readily soluble in soda, being much weaker acids than carbolic acid, and hence the partition coefficient between the oil layer and the soda layer is so large that a considerable number of washings with comparatively large volumes of soda solution are necessary. In practice it is found that a total volume of 10 per cent soda solution equal to the volume of the oil washed, is necessary for the complete removal of the phenolic bodies. The cost of these washings, added to that of the distillations, would make it impossible to produce the refined oil at a profit in normal times. As a fuel, however, the crude unwashed oil might find a market, but in this state it could only compete with coal tar creosotes, for which the uses are limited and the price low.

It was thought that possibly by "cracking" the oil, benzenoid compounds might be obtained in sufficient quantity to make the distillation profitable, but small-scale experiments in which the oil vapors were passed over coke at 800 deg. C. gave no encouragement for larger experiments.

It must be concluded, therefore, that low-temperature distillation cannot be made to pay on the value of the by-products alone, and hence is useless as a means of utilizing waste fuels of high ash content. The process as applied to valuable coals is in somewhat a different position, for in this case a residue of "smokeless" fuel is obtained. At present it cannot be claimed that there is any very large market for such fuel in competition with coal itself, but what market may be created in the future it is impossible to estimate. Legislation in favor of smoke abatement would, of course, give a great impetus to the use of semi-carbonized fuels, since most boilers and all domestic fireplaces are not designed to burn ordinary coke, whereas the semi-carbonized fuels obtained by the low-temperature distillation of coal can often be burnt more or less successfully in existing apparatus, but they would then find a severe competitor in gas firing. Unless such measures are taken, however, the ease with which a coal fire can be maintained, and the smaller proportion of ash in a good coal (for by carbonizing the proportion of ash in the residuum is made nearly double that in the coal from which it is produced), will severely handicap the extended use of smokeless fuel.

Powdered Fuels

Use of Low-Grade Mineral Fuels.—In the General Electric *Review* for August, 1917, F. PARKMAN COFFIN, of the research laboratory of the General Electric Company, presents some interesting and important data on pulverized coal and the use of low grade fuels. Some extracts from the article are as follows:

"The efficient utilization of our fuel supplies is a subject of constantly increasing importance. Interest in this subject in America has usually been confined to the advocates of the conservation of our natural resources. The fuel supply is still abundant and it has usually been cheaper to burn high-grade coal, or fuel oil, than to bother with peat, lignite, or some of the poorer grades of coal containing a high percentage of ash. In some mining districts a portion of the coal is regarded as refuse for filling, or thrown on the culm piles.

"The reserves of bituminous coal and lignite in the United States are immense, but the supply of some of the higher grades, such as coking coal and anthracite, may be exhausted during this century.

"The unrestricted use of our better grade fuels and the ruthless waste and neglect of fuels that should be of real commercial value are phases of our national extravagance that are little short of appalling. The Bureau of Mines has repeatedly called attention to the rate at which the supplies of high-grade fuel are being depleted, and the need of investigations to ascertain how waste in their mining and utilization can be lessened or prevented.

"In spite of the immense resources, we are now face to face with a serious coal shortage, owing to limitations of transportation and of labor at the mines. At the same time there is an unprecedented demand for coal to operate the industries of the country and for war purposes."

"Parts of the country distant from supplies of high-grade fuel should endeavor to utilize their local resources to a greater extent than heretofore, in order to eliminate the expenses and uncertainties of transportation. Also the development of low-grade fuel deposits should be stimulated and established on a permanent basis."

"The production of high-grade coal and petroleum is more or less localized, but nearly every section of our continent has local fuel resources within moderate distances of points of consumption. Low-grade fuels are those which have a low calorific value due to the presence of impurities such as ash and moisture. Fine screenings and dust produced in preparing certain high-grade fuels for the market may also be included since it is often difficult to burn them on the grate, when using forced draught, even when mixed with lump coal.

"There is little doubt that the most perfect combustion of highly gaseous coals, like lignites, could be brought about by burning the pulverized material in a properly constructed combustion chamber in a draft of air. Such a method, to a limited degree, has been employed with bituminous waste for years in connection with several industries in which large ovens are used, but the machinery and appliances required have hitherto been too large and costly to permit their general adoption in small heating or boiler plants. There seems no good reason why some satisfactory method of using lignite in this manner in small plants can not eventually be evolved. Pulverization of highly gaseous lignites produces fuel with properties closely similar to those of crude petroleum or crude gas; in fact, pulverized highly gaseous coal like dry lignite, when fed into a furnace with an air blast, gives very largely a gaseous fuel.

"With the temperature of the furnace or the combustion chamber once at the proper point, by means of valves the relative supply of coal and air can be regulated so quickly and so perfectly that nearly complete combustion of the heat producing constituents can be obtained. Besides, with the proper equipment, the feed and the fire should be closely uniform, almost automatic, and requiring comparatively little work from the fireman. Why dry pulverized lignite can be used in small boiler settings to advantage, there is no reason why it should not produce a relatively high heating efficiency, for, in a proper combustion chamber, besides the combustion of fixed carbon, this method would utilize nearly all of the volatile gases, which have high calorific power, a proportion of which is lost by the ordinary methods of combustion to which lignite is subjected.

"Coal can be pulverized more cheaply than it can be gasified and the first cost of a plant for drying and pulverizing is less than for a producer-gas plant. When thoroughly mixed with a blast of air in correct proportion it is practically a gaseous fuel. Powdered coal firing has most of the advantages of gas or oil firing for steam boilers, when properly applied, and in industrial heating its field of application is constantly growing.

"Low-grade fuel may be burned on grates in furnaces of special construction for each class of fuel, and mechanical stokers are available for burning high-ash coal and lignite. It is probable, however, that low-grade solid mineral fuels of all kinds can be burned to better advantage in pulverized form.

"Lump coal, when burned on the grate in a hand-fired furnace, usually requires about 100 per cent excess air. With modern mechanical stokers the usual practice is to use about 50 per cent excess air. With most kinds of pulverized fuel 25 or 30 per cent excess air is sufficient, and with proper attention the amount may be reduced almost to zero. However, the resulting temperature of the fire is a limiting factor. Other factors having a bearing on this being the construction of the furnace, the proportion of heat radiated directly on the tubes, and the fusibility of the ash. A properly constructed furnace and burners should be able to burn any form of pulverized fuel which has sufficient volatile content.

"For the firing of steam locomotives, pulverized fuel offers a method of mechanical stoking that is beyond competition in all parts of the country where oil is not already in use. It also furnishes a means of utilizing neglected fuel."

Cotton Seed Industry

Cotton Seed Products.—In the Journal of the Society of Chemical Industry, July 16, 1917, KAPILRAM H. VAKIL gives a comprehensive article on cotton seed crushing and products, with especial reference to Egyptian and Indian seeds which constitute the bulk of the seeds crushed in the British Empire. Large quantities

of seeds are shipped to England from India but the quantity is very small compared with India's total production. Indian seed is valued in England on the basis of 18 per cent of oil.

Seeds from the Central Provinces are quoted a little higher in the bazaars and are highly valued by the seed-crushers. The hulls with the lint and moisture form about 43 to 55 per cent of the seeds and on an average 48 per cent. The lint from Indian seeds, removable by American de-linting processes, forms about 1.5 per cent of the seed. This includes lint obtained by reginning the cotton balls which are found in the seeds sold in the bazaar.

On a manufacturing scale the following products are obtainable: Lint, 1 per cent; decorticated cake, 40 per cent; hulls, 44 per cent; oil (crude), 13 per cent; wastage, 2 per cent. In the report of one of the oil mills now operating successfully in India the following figures of its working on a large scale were given: Refined oil, 12 per cent; decorticated cake, 42 per cent; hulls, 38 per cent; lint, 1 per cent; soap stock (foots), 2.5 per cent; wastage, 4.5 per cent.

American "Uplands" seeds resemble the Indian seed in many respects. The Indian seed, however, has more lint or short fiber remaining on it after ginning. This condition of the seed requires very careful handling in the extraction process as the fuzzy mass which forms the covering of the seeds absorbs oil very readily from the meal during the preliminary processes of hulling or crushing, this oil being lost to the miller. The Indian seeds are much smaller than the Egyptian and American.

The chief points of difference in the crude oils obtained from these different seeds are: (1) There is a higher percentage of free fatty acid, coloring and albuminous matters in the Indian oil than in the Egyptian or American oils, which gives rise to a greater loss in refining, sometimes exceeding from 16 to 20 per cent. (2) The oil from Indian seeds is poorer than American and Egyptian oils in the solid "stearin" obtainable from it, and not quite so well suited for margarine making. Egyptian and Indian oils are inferior in color to American oils. (3) The oil from Indian seeds retains a peculiar fishy odor which it is very difficult to get rid of even with drastic treatment. (4) The greatest drawback to the oil from Indian seeds as an edible oil is that the refined oil shows a bluish-green fluorescence. This fluorescence is not removed by the ordinary process of refining. If the traces of fishy odor and the fluorescence could be removed easily and at small cost the oil would find a ready market in India as an edible oil. At present, though sold in large quantities as edible oil, it does not command as high a price and is not valued so much as the best grades of cold pressed Til oil. (5) The refined oil from the Indian seeds has a higher iodine value—112 to 116—than the oil from Egyptian seeds, which varies from 106 to 108, or the American, which varies from 105 to 110. This higher iodine value may be due to the fluorescent substance in the oil.

The author then takes up a discussion of storage and transportation of the seeds in ships. The different processes of crushing are then discussed, with considerable detailed information on the various products. A discussion follows the paper.

Explosives

British Inspectors Report.—In the Journal of the Society of Chemical Industry for July 16, 1917, is given the following account of H. M. Inspectors of Explosives for 1916.

The inspectors report that there has again been a large increase in the number of licensed factories, 23 having been added during the year, making a total of 48 factories added since the outbreak of war. The general condition of the factories, having regard to the exceptional circumstances now obtaining, is highly satisfactory. There has been considerable difficulty, however, in impressing on the picric acid manufacturers the necessity for strict observance of the requirements in regard to cleanliness and freedom from grit in danger buildings. These factories, as a rule, are offshoots of chemical factories which are of necessity difficult to keep clean, and this, no doubt, has a tendency to cause slackness on the part of employees when they are transferred to the picric acid works. Many cases of excessive quantities of picric acid being present in packing sheds have also come to notice.

In March a committee was appointed to test the value of dry powder fire extinguishers as compared with water and other first-aid fire appliances for extinguishing or effectively controlling fires such as are likely to be caused by bombs. The general conclusion arrived at by the committee was that a plentiful supply of water is by far the best extinguishing agent, and that dry powder extinguishers are practically useless for extinguishing or effectively controlling fires likely to be caused by bombs.

Reference is also made to the appointment of the Committee on Dissolved Acetylene.

The Chemical Advisers to the Department report that the total number of samples examined during 1916 amounted to 306 only, about the same as in 1915. The total number (53) of rejections was fairly normal, but the number (35) of rejections for faulty composition was somewhat high. This is, no doubt, partly due to the increased complexity of permitted explosives as a whole, but also, possibly, to some extent because, owing to war work, the manufacturers have not the time for quite such careful supervision of blasting explosives as before. The use of sodium nitrate in the place of potassium nitrate still appears to be causing some difficulty in connection with the heat test, but not to such an extent as last year. The number of new explosives examined (15) was the smallest for a good many years, and consequently the number of samples examined in connection with the Home Office Testing Station was also very low.

The total number of accidents with explosives reported during the year is 641, as compared with 485 for 1915. Of these, 363 occurred in manufacture, causing 195 deaths and injuries to 598 persons; no less than 144 deaths were due to two accidents, namely, 106 in one accident on April 2, and 38 in another on Aug. 21. Of the remaining 51, seven were killed at the Roburite Works on May 15, and seven at the Rainham factory on Sept. 14, and it is hardly too much to say that all these 158 fatalities might have been avoided if, instead of engaging in futile efforts to extinguish the fires, the factory officials concerned had cleared everyone away from the neighborhood. Of the 363 accidents, 146

caused no loss of life or bodily injury, and of those injured a very large proportion received very trifling wounds.

In connection with the conveyance of cordite paste from one factory to another, a proposal was made by those chiefly interested that, instead of being packed in wooden barrels, this material should be forwarded in packages, each consisting of a double bag, the outer one being of stout canvas and the inner of a waterproof insertion material. The reasons given for this suggestion were, first, that barrels are now difficult to obtain, and, secondly, that after arrival at the factory, the barrels are the more dangerous to handle in contact with the very dusty explosive. The question was very carefully considered with special regard to the danger of freezing in cold weather, and it has been finally arranged that the vans in which this material is consigned by rail shall be steam-heated under conditions which will eliminate all danger from overheating, and this arrangement appears to give satisfaction.

In November, Messrs. Dupré carried out some tests to ascertain whether the addition of 2 or 3 per cent of moisture to a fulminate composition would appreciably diminish its sensitiveness and render it safer for filling detonators than the dry composition. The results of their experiments indicated that the addition of as much as 5 per cent of moisture to a mixture of fulminate of mercury and potassium chlorate gives no practical increase of safety either against explosion by shock or communication of the explosion of a portion of the mixture to the remainder, and that such mixtures should be treated with the same precautions as are usual when dealing with dry fulminate composition.

Iron and Steel

Steel for Aeroplanes.—In a paper read before the English Aeronautical Society, Dr. W. H. HATFIELD discussed the subject of steel for aeronautical work. An abstract of the paper is given in *The Jr. Soc. Chem. Ind.*, July 16, 1917. Dr. Hatfield emphasized the importance of using high-class material and of employing scientific methods in works practice. Accurate heat-treatment, based on the thermal phenomena associated with each steel, is essential, and this necessitates in works practice the use of satisfactory and properly standardized pyrometers. The best types of furnace, efficiently constructed and worked, are also required if homogeneous results are to be anticipated in the final product.

Though it has often been pointed out that the term "factor of safety" is misleading, yet its erroneous use continues. A true "factor of safety" should be the ratio between the stress which may be safely applied indefinitely under the actual working conditions to the stress actually employed. The actual values of this factor employed in modern design have been arrived at largely by the method of trial. Better results might be obtained, and fewer mysterious failures result, if the various contingencies to be allowed for were carefully examined and the "factor" placed on a more definite basis.

Among these contingencies is low elastic limit as compared with maximum stress. The difficulty of measuring the true elastic limit militates against this fundamentally important figure being determined as frequently as it should be. Our ignorance as regards the properties of steels below the yield-point is considerable, while of the properties between the yield and the breaking stress it is still greater. Variation of temperature, too, has a marked influence upon the physical properties of steel, and the influence of the ranges of temperature to which the parts have to be submitted in practice should be carefully studied. Corrosion might be carefully and profitably considered, particularly as regards seaplanes. Other items which require attention are the internal stresses left after forging and probably also after heat-treatment, and non-uniformity of material, especially as regards conditions produced by unskillful methods of manufacture and heat-treatment. Inclusions of slag, exaggerated sulphide inclusions, defects caused by unsatisfactory treatment in the forge, and last, but not least, hardening cracks, are also extremely important.

Parts not subjected to shock should be produced from material having a high elastic limit with just sufficient ductility to insure non-brittleness, whereas for parts subjected to severe shock toughness is the more important feature. The division between these two classes of stresses is not very sharp, and in many cases a compromise would appear to have been made between two types of material. All the parts under consideration are of relatively small section, and lend themselves to very careful heat-treatment.

There is such wide divergence of opinion as to the best constructional material for pistons that cast-iron, steel, and even aluminium alloys are all in use at the present time. The author records having had definite indication that piston-heads had spent a considerable time in service above the critical point, 730 deg. C. Generally speaking, the fluctuations of temperature during a cycle of operations take place too rapidly for such changes materially to affect the temperature of the piston or cylinder walls, except just at the skin of the material. The possibility of attainment of extremely high local temperatures at the skin depends largely on the thermal conductivity and specific heat of the material, high values in these tending to reduce the fluctuation in temperature.

For many steels the yield-point is not a definite value. If yield-point is to be taken as a guide as to the value of "true elastic limit," and if elastic limit is to be taken as the basis of design, then this quantity must have much more attention than it usually receives.

The use of impact tests of the Izod and Charpy type is not justified in view of the anomalous results obtained in practice. The torsion test is of particular interest to aero engineers, since any shaft which transmits power suffers torsion, and the natural way of testing the strength of such a shaft or of the material of which it is made should be by torsion.

In discussing the properties of a number of typical steels used in aero work, the author described air-hardening steels as extremely important, and predicted that when they are more completely understood they will be used to a much greater extent than at present. An air-hardening steel heated to temperatures of 800 deg. to 850 deg. C. and allowed to cool in air will have great hardness, whereas the hardness introduced by the same treatment in an ordinary carbon or even a high-tensile steel is in no way comparable. It is the presence of a high percentage of nickel, as well as chromium, that induces the specific property. Such steel, on air-hardening from 800 deg. to 850 deg. C., gives 100 tons per

square inch maximum stress and upward, accompanied by an elongation in the neighborhood of 10 per cent. Such results should be extremely valuable to engineers designing aircraft parts. "Stainless steel," a low carbon steel with 11 to 15 per cent of chromium, is air-hardening, and has the property of successfully resisting the ordinary corrosive action of the weather, change from wet to dry atmospheric conditions, organic acids, oxidizing influences, and sea-water. It should, therefore, have a large application to sea-plane work. At present it is used for aero valves, and would appear to be a possible material for stream-line wires.

A considerable tonnage of sheet steel is employed in aero work, *e.g.*, for manufacturing clips, etc. The steel used for such purposes has usually a low tensile strength, say, 28-30 tons. A higher class of sheet steel is being used containing nickel, which gives approximately 35 tons tensile with a considerably higher yield-point than the mild steel. A drawback against this latter steel is that there is some difficulty in working it.

Recent Metallurgical and Chemical Patents

Iron and Steel

Extraction and Recovery of Impurities in Iron Ore.—A process peculiarly, though not exclusively, adapted to the soft iron ores of Cuba, is patented by Frederic A. Eustis of Milton, Mass. The object of the process is the extraction and recovery of aluminium, nickel, cobalt, manganese and chromium which occur incidentally in the ore, at the same time improving the quality of the iron ore. According to earlier patents of the inventor (1,212,334 and 1,230,143), the object is accomplished by a preliminary heat treatment of the ore in a rotary kiln or hearth roaster, with SO_2 gas at 460° C., followed by dissolution in dilute sulphuric acid or water at 100° C. The aluminium, nickel, etc., go into solution and may be recovered by suitable means of precipitation. While this method is effective, the inventor has discovered that the process can be improved by removing the aluminium from the ore before subjecting it to the sulphating roast. This increases the extraction and recovery of the alumina and makes easier the subsequent reduction of the iron ore.

In carrying out the improved process the ore is first subjected to boiling treatment with strong sodium or potassium hydroxide, dissolving the aluminium compounds, or a substantial part of them, after which the solution is withdrawn and precipitated by aluminium hydroxide. This method regenerates the original precipitant. Or, precipitation can be accomplished with an acid. After this treatment, the original ore is then subjected to the sulphating roast to render soluble the balance of the aluminium and such incidental metals as may be contained. The sulphating roast can be produced by mixing with the ore from 5 per cent to 10 per cent of its weight of pyrite, and heating to 460° C., or the same effect can be produced by treatment with SO_2 gas and air as described above. (1,237,765, Aug. 21, 1917.)

Sintering Finely Divided Iron-Bearing Material.—A contribution to the methods of sintering or clinkering finely divided iron ore, blast-furnace flue-dust, concentrate or other similar material, in order better to fit it for treatment in the blast-furnace, is made in a process patented by Frederick W. Yost of Chicago. The process consists in subjecting the material, intermittently or continuously, to roasting or calcination by means of a current of reaction-supporting furnace gas conducted through the mass, the surface of which is heated during the period of reaction. As applied to finely divided iron oxide, the material is mixed with powdered fuel and charged onto the grate of a suitable furnace. Flame or furnace gas, produced from any fuel adapted to the purpose, is brought into contact with the mass surface, and part or all of the gas is drawn downward through the charge. The material is heated uniformly and progressively from top to bottom, and the clinkering reaction initiated at the upper surface is propagated downward through the charge, but at a slower rate than the progress of the heating zone. The process may be applied to the clinkering of cement materials. (1,231,831, July 3, 1917.)

Gold and Silver

Extraction of Gold and Silver from Ore Containing Manganese Dioxide.—According to the specifications of a patent granted to Martinus H. Caron of Weltevreden, Java, Dutch East India, the customary low extraction of silver from a gold-silver ore containing large quantities of manganese dioxide, are avoided by a preliminary reducing roast, using CO gas or other reducing agent in the operation. The effect is said to be beneficial for either cyanidation or amalgamation, yielding a silver recovery varying from 93 per cent to 99 per cent. The highest extractions are obtained from ores containing the largest quantities of silver. (1,232,216, July 3, 1917.)

Oil Flotation in Cyanide Solution.—A combination of oil flotation with the cyanide process is patented by John M. Tippett of Colorado Springs, Colo. The object of the process is not only the recovery of the precious metals, but also any base metals which may be in the ore. The scheme is applicable to gold and silver ores in general, but particularly to those of the Cripple Creek district, Colorado. The crushed and ground ore is mixed with cyanide solution in equal quantities, the strength of the solution varying with the ore to be treated, from one-quarter of a pound to four pounds of cyanide per ton of water. The mixture is then ground in a suitable mill, the acidity of the ore being neutralized by the addition of suitable alkali, preferably NaOH. The addition of this material is of assistance in effecting subsequent flotation. A suitable flotation oil also is added to the pulp as it flows into the grinding mill, where a thorough mixing takes place. After the pulp issues from the mill it receives an addition of cyanide solution, making the ratio of ore to solution 1:3 or 1:4. The mixture is then conducted to a pneumatic flotation cell, such as the Callow, where the richest and finest minerals are floated and recovered. This mineral is most difficult to recover on concentrating tables as well as most refractory to cyanide solution. The flotation tailing is run over concentrating tables for the recovery of the coarser particles of mineral which escape flotation, and the table tailing, in turn is thickened and agitated in the customary manner for dissolution of the gold and recovery of the pregnant solution. (1,236,501, Aug. 14, 1917.)

Continuous Agitation and Decantation of Slime Pulp.—A method for automatically controlling the continuous agitation and transfer of slime pulp in cyanidation or other hydrometallurgical process is the sub-

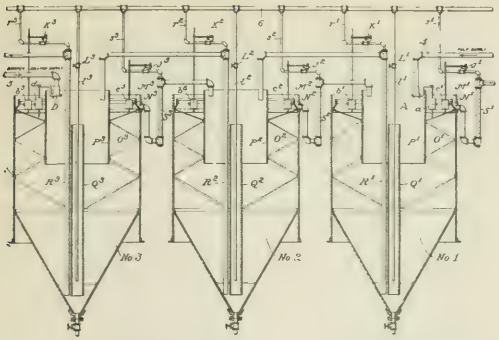


FIG. 1—AUTOMATIC CONTROL IN CONTINUOUS AGITATION AND TRANSFER OF CYANIDE PULP

ject of a patent granted to JOHN W. BUCHER and RANDALL P. AKINS of Denver, Colo., and by them assigned to the Colorado Iron Works Co. of Denver. The system is shown in sectional elevation in Fig. 1. It comprises a series of automatically operated controlling valves for regulating the transfer of the pulp from one agitation tank to the next, and for simultaneously regulating the transfer of a counter-current of barren solution through the tanks in an opposite direction to the flow of pulp. Fig. 1 shows three agitation tanks, 1, 2 and 3, provided with centrally located annular skirts P^1, P^2 and P^3, forming inclosed portions in which the pulp can be agitated and providing outer annular settling spaces O^1, O^2 and O^3, in which clear solution can remain practically undisturbed, ultimately flowing through weirs M^1, M^2 and M^3 into launders N^1, N^2 and N^3, extending around the circumference of the tank. Pulp flows into the right-hand tank through pipe 4, and barren solution into the left-hand tank through pipe 5. Compressed air is supplied through the header 6, from which it is conducted by branch pipes to the places where it is used for agitation and elevation of the pulp. The pulp is thus transferred from one tank to the next through pipes R^1, R^2 and R^3, air being supplied through pipes r^1, r^2 and r^3, each of which has a controlling valve, K^1, K^2 and K^3, respectively, automatically operated by floats b^1, b^2 and b^3. A similar set of solution transfer pipes S^3, S^2 and S^1 are provided, extending from the launder at the top of one tank to the space inclosed by the annular skirt in the next. Air for lifting is supplied by appropriate pipes, each provided with its controlling valve automatically operated by its float.

The operation of the device is as follows: If for any reason the pulp supply should diminish, the level of the solution in the annular space O^1 would tend to fall, thereby lowering the float a and floats b^1, b^2 and b^3, thereby tending to open the supply valve A and close the valves K^1, K^2 and K^3, shutting off the air supply and diminishing the amount of pulp transferred. Should the pulp supply increase, for any reason, the tendency would be to reverse the operation of the device and increase the amount of pulp transferred until equilibrium was restored. Similar reasoning applies to the counter-current transfer of solution. Should the air supply cease suddenly, the air-lifts would stop operating, the solution would rise above the weirs and automatically close the valves A and D, shutting off supplies of pulp and barren solution. The counter-current of barren solution lowers the value of the resulting solution by dilution, and of the remaining pulp by further dissolution of valuable metal. (1,219,240, March 13, 1917.)

Copper, Lead and Zinc

Hydrometallurgical apparatus for the recovery of copper by precipitation of the metal from neutral solution by sulphur dioxide is patented by EDWARD R. WEIDLEIN of Thompson, Nevada, and assigned by him to the Metals Research Co. of New York. The patent specifications relate to the process as developed by Mr. Weidlein at the smelter of the Mason Valley Mines Co., Thompson, Nevada. This process was described in METALLURGICAL AND CHEMICAL ENGINEERING, Oct. 1, 1915, page 652. The chemistry of the process consists in dissolving copper from copper-bearing material with sulphuric acid, and precipitation of the metal from this solution by treatment with sulphur dioxide at a suitable pressure and temperature. The precipitation is accomplished according to the reversible reaction

$$CuSO_4 + SO_2 + 2H_2O = Cu + 2H_2SO_4.$$

The ore is leached with a 3.6 per cent solution of sulphuric acid. The free acid is then neutralized, and the solution containing about 1.5 per cent copper is mixed with approximately an equal amount of sulphur dioxide and then heated to a temperature of about 150° C. at a

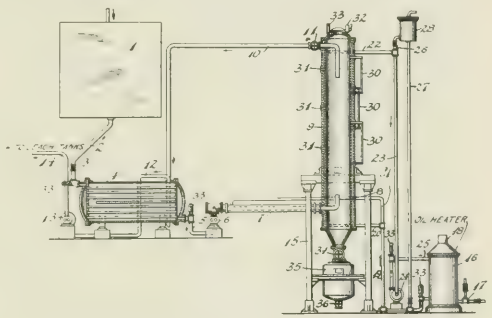


FIG. 2—HYDROMETALLURGY OF COPPER

pressure of 100 lb. per sq. in. Copper is thus precipitated substantially quantitatively and a leaching solution is regenerated.

Apparatus for this process is shown diagrammatically in Fig. 2, consisting of a tank 1 for storage of copper sulphate solution after it has been neutralized and charged with sulphur dioxide; a heat interchanger 4 in which heat from the precipitated solution flowing from the precipitating tank 9 is used to preheat the pregnant solution flowing to the precipitator; an oil heater 16 in which oil is heated for circulation around the precipitator to keep the contents at a temperature of 150° C.; and suitable accessory apparatus in the form of pumps, oil-expansion tank, etc.

In operation, the prepared copper sulphate solution, containing about 1.5 per cent copper and an equivalent amount of sulphur dioxide, is passed through the heat interchanger where it is preheated by the hot precipitated liquor coming from the top of the precipitating tank. The preheated pregnant solution is then pumped under suitable pressure through the oil-jacketed pipe 7 where it is further heated before entering the precipitator. The precipitation of the copper is accompanied

by the regeneration of twice as much sulphuric acid, theoretically, as required for extracting a corresponding amount of copper, as shown in reaction given above. The regenerated solution is then passed through the heat interchanger, where it preheats the solution passing to the precipitator and where it is itself cooled from 150° C. to about 90° C. and again used as a leach liquor. When a precipitator is constructed 3 ft. in diameter and 20 ft. high, having a capacity of about 1000 gal. of solution, it is possible to handle from 50,000 to 100,000 gal. of solution in 24 hours, the operation being practically continuous. (1,223,454, Apr. 24, 1917.)

Furnace for Purifying Zinc from Lead and Iron.—A furnace for the treatment of impure zinc and the separate recovery of pure zinc and such impurities as lead and iron is patented by Richard Ziesing, and assigned by him to the Grasselli Chemical Co. of Cleveland, O. A representation of the furnace is given in Fig. 3. It

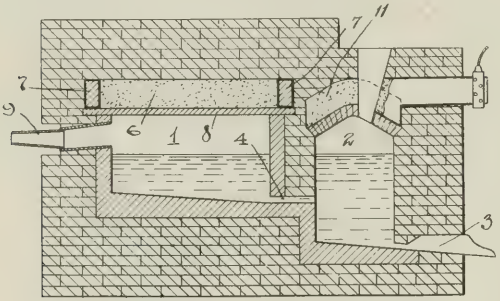


FIG. 3—FURNACE FOR PURIFICATION OF ZINC

consists of two chambers 1 and 2, arranged as shown and connected by a passage 4. Chamber 2 has a charge opening at the top and a drainage conduit 3 at the bottom. Chamber 1 has but one opening at 9, through which the purified zinc is passed to a suitable condensing apparatus. The furnace may be heated in any preferred manner, but is here shown as being heated by electrical resistance elements placed in the roofs of the two chambers at 6 and 11. In starting operations, crude metal is charged into chamber 2 and is there heated until the level of the molten metal approximates that shown in the illustration. Heat is then applied in full force in both chambers, and the metal in chamber 1 is continuously distilled, being collected in a condenser. As fast as zinc is removed by distillation, the charge is replenished in chamber 2. The impurities, lead and iron, being heavier than zinc, tend to collect at the bottom of the chambers. When the accumulation is so great as to affect the purity of the distilled zinc, lead and iron can be drawn from the furnace through the discharge 3. When this operation is about to be performed, the temperature in the furnace is dropped to about 450° C., or slightly above the melting point of zinc. (1,237,141, Aug. 14, 1917.)

Flotation

Selective Separation of Oxidized Ores by Flotation.—An improvement in the selective or fractional separation of oxidized mineral constituents of an ore by means of flotation is patented by Raymond F. Bacon of Pittsburgh, Pa., and by him assigned to the Metals Recovery Co. of New York. The process is applicable to ores containing acid-soluble and acid-insoluble constituents, the latter, however, being convertible into sulphides by treatment with hydrogen sulphide or other soluble sulphide. Whence, by treatment of such an ore with acid and a soluble sulphide, the acid-soluble constituents will go into solution and the sulphide will convert the acid-insoluble minerals into sulphides. Oxidized ores can be treated direct, but some sulphide ores may require a preliminary roast to convert the minerals into a form more readily amenable to the process.

In the latter case, for example, zinc-lead sulphides existing in intimate physical combination may require a roast in order to facilitate the extraction of zinc as an acid-soluble sulphide and convert or complete the conversion of the lead into lead sulphide which is acid-insoluble. Similarly, copper-iron sulphides may require a roast to yield a product in which the original iron sulphide is converted into an acid-soluble sulphide, while the oxidized and dissolved copper will be sulphidized because of the insolubility of copper sulphide in acids. The sulphidation, as well as the solution of the soluble constituents, will occur simultaneously.

When the sulphidation and solution reactions are completed, the ore is subjected to flotation to effect the removal of the sulphides. This separates the insoluble sulphides from the acid-soluble metals, and after flotation the latter can be separated by flotation treatment by first converting them into sulphides after neutralization of the excess acid. An alkaline sulphide can be used for this neutralization. (1,235,954, Aug. 7, 1917.)

Sulphidizing Oxidized Ores for Flotation.—An improvement in preparing oxidized ores for flotation by converting them into sulphides through treatment with hydrogen sulphide, is patented by George D. Van Arsdale of New York City. An obstacle hitherto encountered in sulphidizing copper oxide ores with hydrogen sulphide has been the difficulty of ascertaining the exact amount of hydrogen sulphide necessary, and the avoidance of a deleterious excess. The present invention resides in the discovery that the proper amount of hydrogen sulphide is that required to convert all the copper oxide to sulphide, together with an additional amount of the reagent not in excess of the amount that can be absorbed and neutralized by the pulp; and of the further fact that such excess, which hitherto has been found detrimental, may be rendered harmless by allowing a certain amount of time for its absorption and neutralization. The necessary steps in the operation are: 1. Generation of the hydrogen sulphide. 2. Absorption of the reagent by the pulp. 3. Time of standing. 4. Flotation. Hydrogen sulphide can be generated by the action of acid on low-grade copper matte. The gas can then be brought into contact with the pulp in a suitable agitation vessel, and after this treatment the pulp can be transferred to another vessel, where it may be allowed to stand for the complete absorption of the gas. Usually from two to four hours' time will be found sufficient for this step, after which the pulp may be treated by flotation. (1,236,504, Aug. 14, 1917.)

Electric Furnace Developments at Sheffield, England

In view of the large amount of munition work now being done in this country and the accumulation of borings that is likely to result, the experience of British

steelmakers as given in the following extract from the *Sheffield Telegraph*, Aug. 28, should prove interesting:

The abnormal demand for munitions has, perhaps, done more than anything else could have done towards breaking down the prejudice against electric steel. Before the war had been in progress many months our armament makers found themselves accumulating enormous quantities of borings, turnings, screwings, etc., of very high grade steels, containing chrome, nickel and other costly alloys. In ordinary times these turnings were of comparatively little value on account of the difficulty of remelting them without the loss of most of the alloys. But when the quantities of turnings produced in munition making became abnormal, it was at once realized that the best solution of the problem of utilisation was afforded by the electric furnace, because it was capable of saving all the nickel and almost all the chrome, whilst remelting the scrap, besides which it could, if necessary, oxidise the chrome whilst retaining the nickel. Admittedly, no type of electric furnace was exactly perfect; but with a view to further perfection in the matter of treating these turnings, certain Sheffield metallurgists set to work in earnest to see what could be done to meet the new conditions. This resulted in the development of the furnace known as the Greaves-Etchells furnace, by Messrs. Greaves and Etchells, both of Sheffield.

The number of electric furnaces in Sheffield now built, or building, is about forty, with every probability of a further increase. Turnings, borings, etc., are being converted into steel for shells, rifle barrels, light armour plates, and aircraft. Until the introduction of the electric furnace, there was no type that could melt more than a somewhat limited proportion of turnings per heat. It was necessary to use a large percentage of new raw materials, such as pig-iron, bar-iron, etc., along with the scrap. Now not only is it possible to have a whole heat of turnings, but to have "boils" of ten and even fifteen tons, by the electric process, whereas prior to the war few electric furnaces were of more than 2½ tons capacity. Now these larger furnaces can make sound steel direct from turnings, and at less cost than by the crucible process. The introduction of this type of furnace is, perhaps, one of the most outstanding features of war-time developments in our local industry.

Mr. Greaves is a local expert electrical engineer, and Mr. Etchells is an expert Sheffield metallurgist. These inventors offer a special furnace of small capacity for the production of high-speed and other tool steels, besides the larger furnace for the melting of turnings.

One advantage of the electric furnace is that it requires less space per unit of output than a crucible steel plant. The initial cost is about the same in the case of the electric furnace as of the coke-fired crucible plant, but the saving in space is important, whilst there is a further marked economy where the electric current can be supplied at a reasonable cost. Electricity is already being generated cheaply, compared with the cost ten or twenty years ago. When we consent to harness the tides, or to utilise the water power latent in our rivers, or scientifically to convert our coal into energy at the mines, and so produce electricity at the lowest possible cost, electric iron smelting and steel melting and refining will probably enter upon a wide avenue of development.

A New High-Frequency Induction Furnace

An interesting development in small electric furnaces has been made by Dr. E. F. Northrup of Princeton University in conjunction with the Pyrolectric Instrument Company of Trenton, N. J., and under the direction of the Ajax Metal Company of Philadelphia, Pa.

The furnace (shown in Fig. 1) uses oscillatory currents for the generation of heat. By the use of a highly effective induction without the interlinkage of a magnetic with an electrical circuit, currents can be set up in the containing crucible in the case of a non-conducting melt, or in the melt itself, if the same has sufficient conductance. It is possible to raise the temperature of a melt in a crucible until its resistance becomes low enough to permit the generation of heat in the substance itself (as in the case of melting glass), after which the temperature producible is limited only by the durability of the insulation and container.

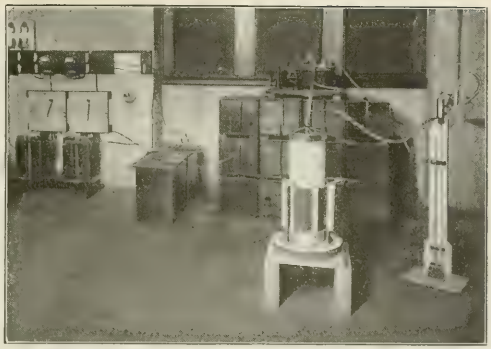


FIG. 1—HIGH-FREQUENCY INDUCTION FURNACE

The furnace is especially suitable for alloy research at temperatures above 1400 deg. C., inasmuch as it makes possible the running of melts in vacuum or in any atmosphere desired, particularly in one free from carbon. With a 20-kw. furnace, which is the largest size so far built, a temperature of 1620 deg. C. has been easily attained. Theoretically there is no temperature limit, but practically there is a limit because of the necessity for proper heat insulation between the containing crucible and the outside coil.

What is actually accomplished is to induce countless eddy currents in the melt itself, providing same is a conducting substance, by the use of oscillating current at a frequency of about 12,000 cycles. If the melt is of a non-conducting substance, such as glass, a conducting crucible such as graphite is used. Eddy currents are then induced in the crucible, which in turn heats the glass, rendering it conducting as it rises in temperature, after which eddy currents are set up in the glass itself.

Increased Exportation of Crude Oil and Petroleum Products

Exports of petroleum and its products from the United States during the twelve months ended June 30, 1917, showed increases in both quantity and value over the preceding twelve-month period. The increases in value were proportionately greater than the increases in quantity. The most noteworthy increases were those in exports of gasoline and naphthas, which increased 44 per cent in quantity and 92 per cent in value. Exports of lubricating oil showed a large increase in value as compared with the increase in quantity. The following table shows the quantity and value of petroleum and its products exported during the fiscal year ended June 30, 1917, as compared with the previous year.

		12 Months Ending June 30— 1917	1916	Per Cent of Increase
Illuminating oil	gallons	835,114,403	823,143,138	1
	value	$54,662,094	$52,283,057	4
Gasoline and naphthas	gallons	425,703,130	294,779,809	44
	value	$87,971,263	$45,770,274	92
Lubricating	gallons	271,028,546	250,395,439	8
	value	$48,649,557	$37,452,084	29
Residuum products	gallons	1,041,223,680	911,397,068	14
	value	$32,507,685	$25,157,423	29
Crude oil	gallons	176,368,675	163,732,589	7
	value	$7,162,550	$5,754,084	24
Totals	gallons	2,749,438,434	2,443,448,043	16
	value	$230,953,149	$166,416,922	38

Temperature Indicator for Electrical Machines

Many parts of the dynamos and motors used in generating and using electrical power are quite inaccessible to thermometers, although frequently subject to dangerous overheat. To overcome this condition in the larger capacity machines, and also to provide means of warning operators stationed at a distance from their dynamos of the rising heat, the General Electric Company of Schenectady, N. Y., has developed a temperature indicator for electrical machines which is operated by electricity itself.

This device consists of "feeler coils," connecting wire, a few small switches and a "voltmeter." The feeler coils are placed in the dynamo or motor in parts where overheat is especially feared and are then connected to the "voltmeter" which is really the indicating instrument. When the dynamo "warms up," these coils get warm also, and cause the indicating needle of the voltmeter to move over a scale graduated in degrees centigrade, telling the operator just how "hot" the machine is in the part in which the feeler coil is located.

The "voltmeter" or indicator is mounted on a suitable panel, which may be located any desired distance from the generating dynamo.

An Interesting Flotation Process

One of the very interesting exhibits to the metallurgist at the Chemical Exposition was the Groch flotation machine shown by Groch Centrifugal Flotation, Ltd., Cobalt, Ontario.

The Groch flotation plant consists of a tube mill for grinding ore and an oil flotation machine for recovering the valuable minerals. The ore is fed into the tube-mill, along with a small quantity of water, by means of a revolving scoop and the actual grinding is performed by steel balls or hard flint pebbles in the cylindrical body.

From the tube-mill the ground ore in the form of flowing pulp is fed into the first compartment of the flotation machine by means of a pipe. Here it is sucked into the lower part of the first impeller. A minute quantity of a light oil is dropped through the hollow shaft of this same impeller and, falling into the upper part of the impeller, is atomized and dispersed through the large volume of air which is sucked down simultaneously through the same channel.

The pulp and oiled air are ejected together through the impeller at its periphery. During the process, the most easily floated minerals become smeared with oil while the air performs an action similar to that of blowing soap bubbles. The combination of oil, air and mineral then floats to the surface in the form of a scum and overflows to a suitable receptacle. The residue from this first operation is sucked into the second compartment of the machine and the system of treatment is repeated in the second impellor using the same or different class of oil depending on the ease or difficulty with which the remaining minerals may be recovered.

By this system of oil flotation it is claimed to be possible to recover, by preferential selection, various minerals, each in turn, from a complex ore by using different oils or oil mixtures during treatment.

Personal

Dr. **J. S. Agraz,** director of the School of Chemistry of the National University of Mexico, was an interested visitor at the Chemical Exposition in New York, Sept. 24 to 29.

Mr. **Harry A. Curtis,** now First Lieutenant commanding Troop K, Colorado National Guard and formerly professor of physical chemistry in the University of Colorado, has been ordered to report to the Chief of Ordnance at Washington.

Among the distinguished visitors at the Chemical Exposition held recently in New York, were Lieutenant **Rene Engel,** chemical engineer, and secretary of the Societé de Chimie Industrielle of Paris, and Prof. **Victor Grignard** of the Institut de Chimie de Nancy. Both are members of the French Scientific Mission to the United States.

Mr. **M. J. Falkenburg** of Falkenburg & Laucks, chemists and engineers, Seattle, Wash., is on a trip to Anchorage, Alaska, in the interests of the Alaskan Engineering Commission. Falkenburg & Laucks, through Hildreth & Co. of New York, are inspecting materials of all kinds used in the construction of the Government railway in Alaska.

The Pfaudler Co., Rochester, N. Y., has the following men enlisted in the military service: **Henry R. Allen,** assistant salesmanager, Major Cavalry Officers' Reserve Corps; **Otto I. Chormann,** chief chemist, Major 1st Battalion, 3rd Infantry, N. G. N. Y.; **Charles Hayes,** chemist, Sergeant Co. H, 3rd Infantry, N. G. N. Y.; **Louis Strasner,** erector, private, Co. H. 3rd Infantry, N. G. N. Y.; **George E. Gray,** salesman, Corporal, 1st Infantry, N. G. Illinois; **Gordon Kipp,** draughtsman, private, Co. H, 3rd Infantry, N. G. N. Y.; **Elson I. Wright,** accountant, private, Base Hospital Unit 19, Medical Reserve Corps; **Rodney J. Swetting,** industrial engineer, Lieut. E. O. R. C.

Dr. **Alcan Hirsch** will sail for Japan on Oct. 25 on the steamship Empress of Asia to continue his work as consultant for the Japan Dyestuff Manufacturing Company, which is subsidized by the Japanese Government. Dr. Hirsch expects to be in the Orient three or four months.

Dr. **H. B. North,** associate professor of chemistry at Rutgers College, New Brunswick, N. J., has resigned to become connected with the York Metal & Alloy Company, York, Pa., in the capacity of director of the Research Laboratories.

Dr. **Walter Runge,** formerly connected with the chemical plant of the du Pont Powder Company, Wilmington, Del., has resigned.

The following members of the staff of the Asbestos Protected Metal Co. of Pittsburgh are now in Government service: **Stuart S. Caves,** formerly in engineering department, Officers' Reserve, at Fort Niagara; **F. C. Easterby,** formerly district representative at St. Louis, Constructing Quartermaster, Fort Riley, Kansas; **W. C. Fanning,** formerly in engineering department, Officers' Reserve, Fort Niagara; **William H. Hale,** formerly district representative at Minneapolis, Minn., has completed training, Officers' Reserve; **E. G. Irwin,** formerly district representative at Cincinnati, Ohio, now somewhere in the South with Ohio National Guard Regiment; **J. R. Nichols,** formerly district rep-

resentative at Atlanta, Ga., now Captain of Field Artillery, address, Capital City Club, Atlanta; **John B. Williamson,** formerly in erection department, commissioned First Lieutenant of Engineers, and now in Washington; **Walter A. Slingluff,** formerly in skylight department, enlisted with Pittsburgh Regiment of Engineers, and now somewhere in France; **P. J. Young,** formerly chief engineer, commissioned First Lieutenant of Engineers and now somewhere in France; **T. R. Galey,** formerly district representative at Dallas, Texas, Officers' Reserve, Leon Springs, Texas.

Book Reviews

Chemical Control in Cane Sugar Factories, by **H. C. Prinsen Geerligs.** New York: D. Van Nostrand Co.

The name of Prinsen Geerligs in cane sugar literature is sufficient to command a respectful hearing. A book on the chemical control of cane sugar factories from one who has long been identified with the Java sugar industry and who is recognized as one of the foremost authorities in this field will be of interest to all concerned.

While the present volume is a revision of a book with a similar title published in 1905, it has in its present form almost doubled in size and is largely a new work in many respects. While some may at first be disappointed that it lacks the scholarly character of some of Geerligs' other publications, this is hardly a valid criticism when the purpose for which the book is written is understood. It is intended as a guide and working manual for the "European chemist" who goes to the tropics to take charge of the laboratory of a cane sugar factory with no trained help except that of his native assistants. From the fact that all the methods and calculations and a list of the necessary laboratory equipment are given in such detail, it may also be inferred that the European chemist is frequently a man who lacks experience in cane sugar work.

We hence find that the book is written in the style of a set of directions, with very little theory or discussion, but with all operations described in great detail and with model forms for all the technical reports. The control prescribed is a thorough one, although one wonders that no mention is made of the alpha-naphthol test for condensed waters.

The book is divided into several parts of somewhat unequal length. The first part is of considerable importance because it contains all the sampling and analytical methods. The author's experience enables him to make a wise selection here. The following three parts deal with the determination of actual and calculated weights, with stock taking and with miscellaneous calculations. The impossibility of obtaining an average sample of the cane and the general use of maceration make it necessary to employ a great many indirect methods in calculating weights and percentages. The author's experience and judgment are of value on these questions. An interesting suggestion in connection with unknown losses is contained in the following: "In case the unaccountable losses are too great to be neglected, a record is made in the same way for the solids in order to obtain a good insight into the character of the loss. Chemical losses, occasioned by inversion, souring, superheating, etc., are found in the sucrose account, but not in that of the solids; while mechanical losses, such as spilling, boiling over, etc., are also recorded in both sucrose and solids accounts."

The book is copiously provided with tables. In this, the English edition, the language is not always smooth, and is sometimes even obscure. The book is, of course, written largely from the standpoint of Java practice, but it should be of great value to every cane sugar chemist.

Explosives. By **Arthur Marshall,** A.C.G.I., F.I.C., F.C.S., Chemical Inspector Indian Ordnance Department of Great Britain. Second edition. Two volume. Vols. I, xv and 408 pages; 77 illustrations. Vol. II, ix and 387 pages; 80 illustrations. Price $16. Published by P. Blakiston's Son & Co., 1012 Walnut Street, Philadelphia, Pa.

At no time in the world's history has the manufacture and the use of explosives attained such importance as the present. Before the Great War plants manufacturing several thousands of pounds of smokeless powder a day were considered large; the enormous demand for propellants now requires many plants each of whose output per diem is expressed in hundreds of thousands of pounds. New explosives have been developed to meet new demands or to circumvent a shortage of raw material, and old explosives have been put to new uses. Much useful information and valuable experience has thus been acquired which has not been published.

The daily papers have made us all familiar with such words as picric acid, ammonal and many others, the letters "TNT" have concealed the identity of one of the most used military high explosives. The production of these and other little known chemical compounds have assumed large proportions. We have recently learned the importance of the minute quantity of material contained in the percussion cap.

Not only has the demand for military explosives been great but also larger quantities of commercial explosives have been needed to meet the inflated demand for the products of our mines. Dynamite has been called upon to increase the productivity of the soil.

The knowledge acquired during the last few years has not been published in collected form and much can only be found in technical journals in foreign languages; the first edition of this work has been made somewhat obsolescent by the rapid advance of the art. Marshall's Explosives therefore fills a distinct want as it is by far the most comprehensive work on the subject yet published and is up to date. The whole field is covered with as much detail as is possible in a work of this extent, the amount of space devoted to each subject being well balanced. The man in the industry will broaden his outlook and his lay brother gain authoritative knowledge from these volumes.

Volume I is subtitled "History and Manufacture." The historical part takes about fifty of the four hundred pages. The remaining pages are devoted to the manufacturing process under the following subdivisions: Black Powder, Acids, Nitric Esters of Carbohydrates, Nitric Esters of Glycerine, Nitro-aromatic Compounds, Smokeless Powders and Blasting Explosives. Under Nitro-aromatic Compounds we learn about the manufacture of trinitro-toluene or "TNT," picric acid, etc. Each of these subdivisions is treated

with as much detail as is necessary for a thorough understanding of the manufacturing process described. In writing on the subject of explosives the author is restrained in some instances by the fact that many of the details of these processes cannot be published, also as the author states "Details of manufacture . . . can only be learned properly in the factory." The part on Acids deserves particular attention, the difficult subject of mixed acids, the basis of all nitro-compound manufacture, is well handled.

Volume II is subtitled "Properties and Tests." It is subdivided into Properties of Explosives, Some Special Explosives, etc., Stability, etc., Materials and Their Analysis. There are three appendices.

The subject of "Properties of Explosives" is particularly well treated. The qualities of an explosion are explained together with the tests for and the determination of these qualities. It is the quality of the explosion produced that determines the use to which an explosive is put.

Under the subdivision "Some Special Explosives, etc.," the manufacture and testing of time fuses, shrapnel, hand grenades, commercial high-explosives, coalmine explosives, fireworks, etc., are treated in detail.

Under the subdivision "Materials and Their Analysis," special methods are described for the chemical analysis of practically all of the raw and finished products used or produced in the manufacture of explosives. The analytical methods are well chosen.

The two volumes are extensively and separately indexed both as to subjects and names, making the work quite available for reference. The name index and the copious references in the text constitute a comprehensive bibliography.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Friday, Oct. 5.—Copper and lead are unchanged. Tin is off about one cent per pound and spelter is slightly weaker. Silver has had just as sensational a decline as its advance. At the present writing it is quoted at 92⅛. An interesting metal to watch is aluminium which is now down to about 40 cents. Antimony remains unchanged.

Copper.—Since the fixing of the price of copper at 23.50 cents by the Government, producers have declined to quote. Dealers made a few offerings at 26.00-26.50 cents but the market in general has been very dull. Producers are not making any deliveries except on Government orders. The following committee has been appointed to assist the Government in handling the copper situation. C. F. Brooker (chairman), American Brass Company; Barton Haselton, Rome Brass & Copper Company; W. F. Banker, General Electric Company; L. H. Jones, Detroit Copper & Brass Rolling Mill Company; G. P. Miller, Bridgeport Brass Company; A. L. Salt, Western Electric Company; Carl Roebling, J. A. Roebling's Son Company; G. A. Cook, Taunton-New Bedford Copper Company; D. M. Brady, Brady Brass Company; M. H. Howard (secretary), National Conduit & Cable Company.

Tin.—Arrivals in September were small, about 2500 tons. Spot Straits is quoted at 60.75 and No. 1 Chinese at 56.00. The statistics for the month and year as given by the New York Metal Exchange and American Metal Market are as follows:

		Tons.
Arrivals at Atlantic ports amounted to		2,405
Arrivals at Pacific ports		3,302
Total arrivals since Jan. 1, 1917		44,837
Deliveries for September—		
Atlantic ports	2,100	
Pacific ports	3,302	5,402
Total deliveries since Jan. 1, 1917		45,951
Deliveries same period in 1916		44,413
Estimated shipments from Straits		5,000
Against previous month		5,770
Against September, 1916		3,270
Statistics for the United States—		
September 30th, show as follows:		
Stocks, including on dock and landing		2,397
Afloat		5,175
The total statistics for Europe and the United States show:		
Total visible supply Sept. 30, 1917		19,153
Against " Aug. 31, 1917		20,353
" " Sept. 30, 1916		16,192
" " Dec. 31, 1916		20,737

Lead.—There is no change in price from the trust price of 8.00 cents. The buying element has been very small.

Spelter.—Prompt spelter is quoted at 8¼-8½ cents. Brass special is 8.75 St. Louis. The Government has purchased 2,000,000 lb. of Grade "B" at 10.67½. Generally the market has been dull.

The Iron and Steel Market

Since the inception of price fixing in the iron and steel industry the market has been practically inoperative, this condition succeeding to that of stagnation which had obtained for about three months. The meeting at which an agreement between the Government and the producers was reached was held in Washington Sept. 21. The majority opinion in the trade had been that an agreement could not be reached, and even during the progress of the meeting appearances for a time were that a price basis would be adopted by the manufacturers which would be unacceptable to the Administration. The issue was an interesting one. There were three classes of purchases, those by the Government of steel for its own use, those by or for the account of the Government's Allies, and those by the general public. The Administration had the right to fix prices in the first case, but not in the second or third except through further legislation and there was doubt as to the constitutionality of legislation referring to the second case.

In its surface form, the issue was whether the producers would assent to the "one price for all" doctrine of President Wilson, but in practice it became a question what level of prices could be agreed upon. If the prices were made high enough the producers had no ground whatever for objecting to making one price for all. An agreement was reached whereby Lake Superior iron ore prices ruling for the season of 1917 should be continued, pig iron should be priced on a basis of $33 for foundry, malleable and basic at valley furnaces, steel bars should be 2.90c, structural shapes should be 3c and plates shoud be 3.25c. These prices were set merely to form a basis, from which prices for other commodities could be worked out. The pig iron and steel prices are a trifle more than double the average prices in the ten calendar years before the war.

Immediately the producers undertook to agree among themselves upon prices for other commodities which should be in keeping with this price basis, for submission to the War Industries Board, which after final reference to the President will announce prices to the public. There is ground for suspecting that in some cases prices will be submitted by manufacturers which the War Industries Board will have occasion to scale down in order to make them fully in keeping with the adopted basis. One reason for this suspicion is that some of the manufacturers have expressed an altogether untenable theory, that certain prices should be set relatively high, "in order to stimulate production." That would mean, in actual practice, that classes of steel required for prosecuting the war should involve a greater profit than classes of steel not so required, for instance, that there should be a greater profit in making shell steel than in making steel for pleasure automobiles. It is for the Government to find its steel by other methods than by paying premiums.

SYSTEM SATISFACTORY

The system for fixing prices is regarded as eminently satisfactory. It had become fairly well established that if nothing were done voluntarily there would eventually be full legal regulation, undoubtedly with much inequity and certainly with a degree of rigidity that would not conduce to smooth operation. The system is that of the Government accepting a basis which promises to afford a certain volume of profits to the producers, about half of which will pass to the Government in the form of taxes, only a small part of the total profits being the profits on Government orders that remain in the hands of producers. The producers arrange details quite largely, as to relative prices, extras, etc., all under the full supervision of the authorities at Washington, and room is left for the Government to require a reduction after Jan. 1, 1918.

The regulation of sequence in which orders are to be filled, by the Priority Board, is accepted by the producers without so much as a remark. The Priority Board is a subsidiary of the War Industries Board, which has general charge of the making of purchases, both for the Government and for its Allies.

MARKET WILL BE QUIET

The quiet market now being experienced is not merely contemporaneous with the period of price uncertainty, while the full schedule of prices is being developed. The original price agreement, covering iron ore, certain descriptions of pig iron in one district, that go at the one price of $33, and the steel products bars, shapes and plates, hardly count as more than five items, yet it was announced immediately after this agreement that the War Industries Board contemplated fixing prices on about 150 articles of steel. Thus the program is quite extensive and it will certainly be weeks before the entire price list is made out. Then the period of price uncertainty will be ended, and the various market prices previously prevailing will have disappeared.

The quiet market, however, is likely to continue for some time thereafter, perhaps for the duration of the war. There are two incentives to forward buying, one being a prospect that prices will advance. That prospect is now absent. It seems to be the general opinion that if prices are vised after once being fixed they will be revised downward. The second incentive is to secure a place on order books so as to insure delivery before delivery occurs against orders that others may place later. The Priority Board has announced that it will decree deliveries in sequence according to three classifications, material required for war, material not for war but indirectly helping the prosecution of war, and all other. The ordinary buyer does not know how much material there will be in the first category, nor how much will find itself in the second category nor, as a rule, whether his material will be included in the second or the third. Hence, when the mills are already filled with orders representing their output for months to come he can have no idea when delivery would be made against his order. Delivery might be delayed to a time when it would be altogether inconvenient to receive the material. The producer on the other hand could hardly regard the order as doing more than increasing the clutter in his order books. Hence neither buyer nor seller will be much disposed to transact business until the volume of business on books is greatly reduced. There will be a transitionary period, during which much more steel will be shipped than ordered.

Buying of war material promises to be heavy, particularly in the next couple of months. Not only will orders for the Government be placed somewhat more freely, but the large volume of business for account of the Government's Allies, which has been accumulating for months, will be let loose, now that the question has been settled what prices the Allies are to pay. Immediately after the price agreement was reached an eminent authority estimated that the tonnage to be placed in two months would amount to 7,000,000 tons, chiefly, it appears, for delivery in 1918. This would represent a trifle more than 20 per cent of a year's output at the present rate of production, but a trifle less than 20 per cent of a year's output if all capacity were fully engaged, a condition that has not existed for the past ten months, on account of the shortage of coke. As some war steel has already been ordered that will not be delivered until 1918 and as additional orders will follow the placing of those now in immediate contemplation, the total of war steel will probably exceed 30 per cent of the productive capacity. While the remainder appears large, particularly in view of the increased and increasing capacity, steel is certain not to be plentiful in all forms if in any. The rolling industry is highly specialized and the alignment of capacity in the different finishing departments is not in accordance with the peculiar needs of the war.

Chemical Market

COAL TAR PRODUCTS.—The general position of these markets continues more or less quiet, and some items are somewhat easier for the fortnight.

Benzol.—The market is quite far from firm and values are rather lower than the situation seemingly warrants. However, supplies appear to be quite ample at most points.

Aniline Oil.—There is a better feeling prevalent in the aniline oil trade at present, although but comparatively unimportant business is being transacted. The

business is rather restricted owing to the fact that some holders will not release the oil at present prices.

Paranitraniline.—Business remains substantially the same and the demand has not improved perceptibly. A few important inquiries, however, have been noted lately. Production is now much restricted.

Metanitraniline.—This product is being made by a few manufacturers, but difficulties have kept the production low and the steady consuming demand makes for a limited offering.

Monochlorbenzol.—Difficulties in moving supplies are indicated in reports from various sources and prices have been subject to sharp declines for certain brands.

Dinitrochlorbenzol.—Demand is not very heavy and prices are not particularly strong, and an increased production has been noted which has not been attended by a broader demand.

Toluol.—With about 95 per cent of the production going into the manufacture of explosives, and makers working in many cases to capacity to take care of Government requirements in the manufacture of T.N.T., a firm tone is shown in this market. Prices, however, remain firm and are about the same as heretofore.

Dinitrotoluol.—The output has not increased to any extent and producers have little difficulty in selling their product.

Toluidenes.—Demand is not particularly heavy and prices are firmly maintained. Para is strong and active with ortho moving fairly well.

Naphthalene.—A firmer market seems to prevail and considerable material changed hands on a firm basis. Supplies are light and are not being augmented to any extent.

Phenol.—The situation seems to be gradually favoring the large manufacturer, who is slowly coming into his own. The small producer has been eliminated to some extent and the stronger hands now have the situation under better control than for more than a year past.

Dinitrophenol.—This product has been in better request for a while past and sellers are quoting at prices which are more firm.

Para-amidophenol.—There is a fairly good demand for this product and manufacturers are experiencing a fairly steady business, but production is increasing heavily. For the hydrochloride prices are about at same levels.

Heavy Chemicals.—A sharp break in caustic soda on Oct. 1 resulted in the gradual slowing up of business under this classification and at present business is quite unsettled, with difficulty experienced in securing export permits.

Caustic Soda.—There has been a pronounced drop owing to the embargo placed by the Government, effective Oct. 1, 1917, which absolutely prohibits the exportation of this product, and it is thought the purpose of this embargo is that of conservation rather than for preventing this material from entering the enemies' countries. Somewhat of a recovery, however, has been noted in the market and but little business is passing.

Soda Ash.—In view of the uncertainty created by the drop in caustic it is quite difficult to reflect accurate conditions. Business is somewhat uncertain and is at present hanging fire.

Bleaching Powder.—This market has been absolutely neglected and prices have dropped to the level which prevailed prior to the war. Stocks are large and buyers are showing no interest.

Cyanides.—The market at the present writing is somewhat easier and there are more liberal offers of the soda and the mixture. The potash is particularly scarce, however, and but little is offered in this market.

Silicate of Soda.—This situation is in about the same condition, supplies of 60 deg. material being very limited and no supplies of any importance are to be had.

Bichromate of Soda.—Very little change is noted in the last fortnight and prices remain about the same.

Bichromate of Potash.—There is a fairly good tone noted in the market and prices have been firmly maintained.

Chlorates.—There is little change noted in this situation either in the potash or soda, and prices range about the same.

Copper Sulphate.—Quite a flurry was reported recently, and it is thought possible that this will prove the beginning of large purchases for export.

Arsenic White.—There is an excellent demand for this product and sellers continue to get good prices.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET OCT. 5, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.35 —	.36
Acid, acetic, 28 per cent.	lb.	.06 —	.06½
Acetic, 56 per cent.	lb.	.11 —	.13
Acetic, glacial, 99½ per cent, carboys	lb.	.37 —	.38
Boric, crystals	lb.	.13½—	.14
Citric, crystals	lb.	.70 —	.72
Hydrochloric, commercial, 18 deg.	lb.	.02½—	.02¼
Hydrochloric, 20 deg.	lb.	.02½—	.02⅝
Hydrochloric, C.P., conc., 22 deg.	lb.	.02¾—	.02⅞
Hydrofluoric, 30 per cent, in barrels	lb.	.06 —	.06½
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.05 —	.05½
Nitric, 36 deg.	lb.	.07¼—	.07⅜
Nitric, 42 deg.	lb.	.08 —	.09
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 85 per cent.	lb.	.35 —	.39
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3.10 —	3.15
Sulphuric, 60 deg.	ton	27.00 —	30.00
Sulphuric, 66 deg.	ton	35.00 —	36.00
Sulphuric, oleum (Fuming), tank cars	ton	45.00 —	
Tannic, U. S. P., bulk	lb.	1.25 —	1.40
Tartaric, crystals	lb.	.78½—	.79
Alcohol, grain, 188 proof	gal.	4.30 —	4.35
Alcohol, wood, 95 per cent.	gal.	1.10 —	1.12
Alcohol, denatured, 180 proof	gal.	.95 —	1.00
Alum, ammonia lump	lb.	.04¼—	.04½
Alum, chrome ammonium	lb.	.18½—	.19
Alum, chrome potassium	lb.	.23 —	.24
Alum, chrome sodium	lb.	.12½—	.13
Alum, potash lump	lb.	.09 —	.09½
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03¼—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.13 —	.14
Ammonium carbonate	lb.	.12½—	.13
Ammonium nitrate	lb.	.22 —	.24
Ammonium, sulphate domestic	ton	.7 —	.07⅛
Amyl acetate	gal.	4.50 —	4.60
Arsenic, white	lb.	.16 —	.16½
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	70.00 —	
Barium carbonate 97-98 per cent	ton	65.00 —	
Barium chloride	ton	70.00 —	80.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.10 —	.11
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼—	.01½
Borax, crystals, sacks	lb.	.07¼—	.07½
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.70 —	.80
Calcium, acetate, crude	lb.	.06 —	.06⅛
Calcium, carbide	lb.	.08½—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	... —	...
Carbon bisulphide	lb.	.07 —	.07½
Carbon tetrachloride, drums	lb.	.16½—	.16¾
Caustic potash, 88-92 per cent.	lb.	.85 —	.87
Caustic soda, 76 per cent.	lb.	.07¾—	.08
Chlorine, liquid	lb.	.15 —	.20
Cobalt oxide	lb.	1.40 —	1.50
Copperas	100 lb.	1.02 —	1.07
Copper carbonate	lb.	.30 —	.35
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09 —	.09⅛
Cream of tartar, crystals	lb.	.50 —	.52
Epsom salt, bags	100 lb.	4.00 —	4.25
Formaldehyde, 40 per cent	lb.	.16½—	.17
Glauber's salt	100 lb.	.80 —	.85
Glycerine, bulk, C. P.	lb.	.70 —	.71
Iodine, resublimed	lb.	3.50 —	3.55
Iron oxide	lb.	.13 —	.15

Lead, acetate, white crystals	lb.	.17	—	.17½
Lead arsenate	lb.	.15	—	.18
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.10½	—	.12¼
Lithium carbonate	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.12	—	.13
Nickel salt, single	lb.	.12	—	....
Nickel salt, double	lb.	.09	—	....
Phosphorus, red	lb.	1.25	—	1.30
Phosphorus, yellow	lb.	2.15	—	2.20
Potassium bichromate	lb.	.44	—	.45
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.60	—	2.70
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	325 00	—	350.00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.70	—	2.80
Potassium prussiate, yellow	lb.	1.25	—	1.30
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.10	—	.11½
Salammoniac, white gran	lb.	.15½	—	.16
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide, based on market price of silver	oz.	....	—	....
Silver nitrate	oz.	.69	—	.71
Soda ash, 58 per cent. light, flat	100 lb.	3.50	—	3.60
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.11	—	.11½
Sodium benzoate	lb.	1.75	—	2.00
Sodium bicarbonate, domestic	100 lb.	2.45	—	2.50
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.24	—	.25
Sodium bisulphite, powd	lb.	.04½	—	.05
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.90	—	5.00
Sodium nitrite	lb.	.38	—	.40
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.36½	—	.37
Sodium silicate, liquid -40 deg, Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	2 50	—	3.00
Sodium sulphide, 60 per cent, fused	100 lb.	3 75	—	4.00
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3 70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg.	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.16	—	.17
Zinc cyanide	lb.	.50	—	....
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.06	—	.06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	—	.52
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	1.80	—	1.85
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthylamin	lb.	.62	—	.65
Aniline oil	lb.	.26	—	.28
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	....
Benzaldehyde	lb.	4 00	—	4 50
Benzidine, base	lb.	1.60	—	1.80
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	1.75	—	2.00
Benzyl chloride	lb.	1.75	—	2 00
Beta naphthol benzoate	lb.	7.50	—	9.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	....
Dichlor benzol	lb.	.12	—	.18
Dinitrochlorbenzol	lb.	.42	—	.44
Dimethylaniline	lb.	.57	—	.59
Diphenylamine	lb.	1 00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.01⅛	—	.09¼
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P	lb.	.43½	—	.44½
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13 50	—	15.00
Salicylic acid	lb.	1.40	—	1.50
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Fuel Oil

New York	gal.	.10½	—	....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	70	—	1.55
Texas	bbl.	1.60	—	....
Los Angeles	bbl.	1.45	—	....
San Francisco	bbl.	1.45	—	....

Gasoline (Wholesale)

New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.24	—	....
Chicago	gal.	.21	—	....
Oklahoma	gal.	.23	—	....
San Francisco	gal.	.20	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.21	—	.22
Cottonseed oil, crude	gal.	1.15	—	1.17
Linseed oil, raw, cars	gal.	1.20	—	....
Peanut oil, crude	gal.	1.20	—	1.21
Rosin oil, first run	gal.	.35	—	....
Rosin oil, fourth run	gal.	.66	—	....
Soya bean oil, Manchuria	lb.	.15	—	.15½
Turpentine, spirits	gal.	.47	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.65	—	.68
Carnauba wax, flor	lb.	.55	—	....
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	....	—	....
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.11	—	.12
Rosin, 280 lb.	bbl.	6.30	—	....
Soapstone	ton	10 00	—	12.50
Talc, American, white	ton	15.00	—	18.00
White lead, dry	lb.	.10	—	.11

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50 00	—	55.00
Clay brick, second quality	per 1000	35 00	—	40.00
Magnesite, raw	ton	30 00	—	35.00
Magnesite, calcined	ton	40 00	—	55 00
Magnesite, Grecian, dead burned	net ton	85 00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135 00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	....
Ferrochromium, per lb. of Cr	lb.	.35	—	.40
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4 00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	230.00	—	240.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200 00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100 00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton	.90		
Manganese ore, 48 per cent and over, per unit	ton	1.00		
Molybdenite, per lb. of MoS_2	lb.	2.20		
Tungsten, Scheelite, per unit of WO_3	ton	26.00		
Tungsten, Wolframite, per unit of WO_3	ton	24.00		
Uranium oxide, 96%	lb.	3 40	—	3.60
Vanadium Pentoxide, 99%	lb.	11.00		
Pyrites, foreign		Nominal		
Pyrites, domestic		Nominal		

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The Allied Drug & Chemical Corporation, Dover, Del. Capital, $1,000,000. To manufacture chemicals, drugs and kindred products. Incorporators are W. S. Randall, F. A. Armstrong, Wilmington, and C. M. Egner, Elkton, Md.

The Amalgamated Oil-Gas Corporation, New York, N. Y. Capital, $600,000. To manufacture gas making machinery. Incorporators are S. C. P. Dodd, A. F. McCabe and A. E. Moore, 37 Wall Street.

The American International Shipbuilding Corporation, New York, N. Y. Capital, $2,000,000. To operate a shipbuilding works. Incorporators are E. M. Ellsbund and J. E. Manter, New York.

British-American Nitrates Co., Inc., Del. Capital, $2,500,000. To acquire patents in relation to fixation of nitrogen from air. Incorporators are A. J. Gordon, A. J. Knowles, A. Wolf, all of New York.

The Calumet & Massey Copper Company, Inc., Rochester, N. Y. Capital, $250,000. To mine for copper. Incorporators are F. H. Lewis, G. H. Forschler and W. C. Runne, Rochester.

The Chem-Wood Manufacturing Company, New York, N. Y. Capital, $50,000. To manufacture chemical wood and other wood substances. Incorporators are E. J. Welch, R. E. Leavitt and F. Toby, 20 Broad Street.

The Chlorine Control License Corporation, Dover, Del. Capital, $350,000. To manufacture chlorine and other chemicals. Incorporators are S. B. Howard, G. V. Reilly and A. W. Britton, 65 Cedar Street, New York.

The Continental Tire & Rubber Company, Dover, Del. Capital, $300,000. To manufacture rubber tires and other rubber goods. Incorporators are C. L. Rimlinger and F. A. Armstrong, Wilmington.

The Dobbins Core Drill Company, New York, N. Y. Capital, $250,000. To manufacture drilling machines, etc. Incorporators are Thomas H. Dobbins, Roy T. Guthman and R. S. Baldwin, New York.

The Egyptian Manufacturing Company, Newark, N. J. Capital, $100,000. To manufacture disinfectants of various kinds. Incorporators are Alfred C. Eichhorn, Samuel D. Lemon, Newark; and William H. Couper and William J. Smith, East Orange.

F. A. R. Chemical Co., Detroit, Mich. Capital, $10,000. Incorporators are James A. Gordon, Frank A. Ritchie and Nellie A. Martin.

The Galvanizing Corporation of America, Brooklyn, N. Y. Capital, $36,000. To manufacture machinery and chemicals for galvanizing and treating metals. Incorporators are W. Statteler, H. Gerson and I. Seegmiller, 29 Broadway, New York.

M. Gottsman & Co., Inc., New York. Capital, $650,000. To deal in pulp, paper and jute mills. Incorporators are Mortimer Brenner, Samuel Schwartzman, Edgar M. Souza.

The Greene-Wolf Company, New York, N. Y. Capital, $20,000. To manufacture engines and similar products. Incorporators are D. Greene, M. J. Baumgarten and G. W. Wolf, 782 East One Hundred and Seventy-fifth Street, Bronx.

George Hall Chemical Co., Everett, N. Y. Capital, $150,000.

The Inter-tube Chemical Company, Dover, Del. Capital, $1,000,000. To manufacture chemicals and allied products. Incorporators are P. E. Britsch, Brooklyn, N. Y.; C. A. Cole, Hackensack, N. J., and A. R. Oakley, Pearl River, N. Y.

The Iprtecu Chemical Company, Newark, N. J. Capital, $200,000. To manufacture chemicals, etc. Incorporators are M. W. Weinberg, O. B. Reichelt and Walter Scholz, Newark.

The Judaline Machine Company, New York, N. Y. Capital, $100,000. To manufacture metal cans, boxes and kindred specialties. J. A. Moore and A. W. Britton, New York, are the incorporators.

The Kyume Co., Wilmington, Del. Capital, $550,000. To manufacture iron, steel, etc.

The Lake Shore Gas Co., Mentor, Ohio. Capital, $100,000. Incorporators are J. B. Morlide, J. McFadyean, F. Seiberling, S. A. Allen and W. E. Slabaugh.

The Livingston Paper Products Company, Brooklyn, N. Y. Capital, $100,000. To manufacture paper boxes of all kinds. Incorporators are J. A. Albrecht, W. Laier and G. W. Cox, 7 Pine Street, New York.

National Manganese Co., Wilmington, Del. Capital, $200,000. To manufacture iron, steel, manganese, etc.

The Natural Products Refining Company, Jersey City, N. J. Capital, $200,000. To manufacture chemicals and allied products. Incorporators are C. V. Steinhart, Harry A. Goman and Stanley L. Weil, Jersey City.

The Newark Waxed Paper Company, Newark, N. J. Nominal capital, $2,000. To manufacture waxed paper, parchment and kindred products. Incorporators are M. Adelson, Leonard E. Kautzman and F. J. Felbel, Newark.

The New Process Rubber Company, West New York, N. J. Capital, $100,000. To manufacture rubber products of various kinds. Incorporators are John Berger, T. Scheiberger and Reinhard Brueckner, West New York.

New York Potash Corporation, Dover, Del. Capital, $1,200,000. To acquire lands containing alunite, coal and mine for same.

The Nipissing Mines Co., Ltd., Ontario, Canada. Capital, $6,000,000. Will own and control the Nipissing Mining Co., an operating concern.

The Rhe-Ol Laboratories, Inc., New York, N. Y. Capital, $20,000. To manufacture chemicals, chemical compounds, etc. Incorporators are A. Jacobin, S. S. Bworkin and H. Kopeloff, 2018 Belmont Avenue, Bronx, New York.

Right Spot Lead & Zinc Co., Shawnee, Okla. Capital, $100,000. Incorporators are A. E. Simpson, John W. Wayland and Mark Pierce, Shawnee.

Riverside Refining Co., Portland, Me. Capital, $300,000. Incorporators are A. B. Farnham, P. B. Drew, C. G. Trott, Portland, Me.

Southern Sulphur Company, Houston, Tex. Capital, $300,000. Incorporators are John H. Kirby, B. F. Borner and H. L. Fagin.

The Straight Line Mfg. Co., New York City. Capital, $200,000. To make chemicals and polishes. Incorporators are G. H. Bensen, R. A. Van Vechten, N. H. Phillips, 206 Broadway.

The Thousand Islands Chemical Company, Inc., Gouverneur, N. Y. Capital, $5,000. To manufacture chemicals and allied products. Incorporators are C. M. Woodward, J. K. Young and E. C. Jordan, Gouverneur.

The Trenton Decalcomania Company, Trenton, N. J. Capital, $10,000. To manufacture decalcomanias and similar products. Incorporators are C. Sidney Smith, James Hammond and J. H. Hufnagel, Trenton.

Three Buttes Mining Co., Helena, Mont. Capital, $1,000,000. Incorporators are W. G. Bryan, J. D. Cook, T. K. Baker.

The U. S. Smelting Furnace Co., Belleville, Ill. Capital, $50,000. Incorporators are Geo. B. M. Rogers and Arthur Jones.

The Volcancillos Copper Company, Wilkes-Barre, Pa. Capital, $500,000. To mine for copper and other metals. Incorporators are Martin L. Gallagher, A. W. O'Malley, Wilkes-Barre, and C. G. Boland, Jr., Scranton, Pa.

Western Reserve Chemical Co., Cleveland, Ohio. Capital, $50,000. Ed. A. Noll, incorporator.

Financial

ALUMINUM CO. OF AMERICA.—The Boston News Bureau has recently issued a statement giving a few facts on the Aluminum Company of America. During 1916 the receipts were $25,940,427, from the sale of 38,656 long tons of aluminium, the sale price averaging 29.96 cents per lb. In addition 11,080 tons of aluminium was delivered to a subsidiary for the production of various aluminium manufactures. The share capital of the company is $20,000,000, and there are about 300 shareholders, many of them employees. The late C. M. Hall, the inventor of the smelting process, owned $5,000,000 in shares in the company. From 1889 to 1895, the capital of the company was $1,000,000, and the only dividends paid were 4 per cent for 1895 and 6 per cent for 1896. From 1899 to 1901, the capital was $4,000,000, and the yearly dividends were 4¼, 8¼, 7¼, 5½, 6¼ and 6 per cent respectively. From 1905 to 1908 the capital was $3,800,000, and the dividends averaged 10 per cent. In 1909 the capital was raised to $20,000,000, and for the next four years the total dividends were 4.2 per cent. For 1914, 1915 and 1916, the dividends were at the rates of 6, 6¼ and 10 per cent. The company has a yearly capacity of 75,000 tons. With no imports since the outbreak of the war, the company has been called upon to furnish the entire requirements of America, whereas, formerly 40 per cent of the American consumption was imported from France and England. For 1918 delivery the company has quoted 37c. per lb. as its price, although some sales have recently been made at as high a price as 60c. per lb. Though the nominal capital is $20,000,000, the company has a plant investment of over $80,000,000, approximately $70,000,000 of undivided profits having gone back into the property.

CHILE EXPLORATION COMPANY.—During the month of May, the Chile Exploration Company at Chuquicamata produced 3,250,000 lb. of copper, which is an increase over the output for the previous month of April of 222,000 lb. and over that of May, 1916, of 4,586,000 lb.

The total output of the first five months of 1917 amounted to 38,804,000 lb., and compared with the corresponding period of 1916 was as follows:

	1916	1917
January	2,066,782	7,756,000
February	3,144,480	6,056,000
March	3,536,796	8,714,000
April	3,702,327	8,028,000
May	3,664,000	8,250,000
Total	16,114,385	38,804,000

Construction and Operation

Arkansas

RUSH.—The Lonnie Boy Mining Company has completed arrangements for a mill, which will be built this fall.

California

BERKELEY.—The plant of the Pacific Guano & Fertilizer Company will be enlarged soon by an additional building to be erected on recently purchased property. This concern is working night and day to supply the demand for its products. Large consignments were shipped to the Hawaiian Islands this last week.

Colorado

PUEBLO.—Pueblo is to have a chemical plant for the manufacture of sulphuric acid, according to the plans of the Norcross Chemical Company, a concern incorporated for $1,000,000 under the laws of Colorado and which is financed by Denver and Texas capital. The officers are Robert W. Gunnell, president and general manager; Wirt W. Young, vice-president and works manager; Edward W. Love, secretary-treasurer; Dr. Paul Zurcher, chief chemist. The officers and B. M. Hobbs constitute the board of directors. The offices of the company are in the Ideal Building in Denver. The site of the new plant is understood to be located a few miles west of this city. The plant will be a fifty-ton affair and the Zurcher system of extracting sulphuric acid will be used, the process being patented by the chief chemist of the company and the patent rights being held by the company. Clay beds and factory sites were investigated in several places and the Pueblo site was decided upon on account of the suitableness of the raw material and the excellent railroad facilities of this city. The plant site consists of 80 acres. The raw material to be utilized by the company can be obtained from clay beds in the vicinity of Pueblo, it is stated, and considerable material will be drawn from the Stone City district.

Connecticut

HARTFORD.—The Connecticut Electrical Steel Company has had plans prepared and has been awarded a building permit for the erection of a new foundry building at the junction of Flatbush Avenue and Newfield Street, to cost about $25,000. The building will be 195 x 101 ft., one story high.

Florida

JACKSONVILLE. — Announcement is made that the work on the new plant of the Virginia-Carolina Chemical Company, to be located on the municipal dock property just west of the old St. Johns Mill Road near Talleyrand Avenue, will begin Jan. 1 and that an expenditure of $200,000 will be immediately made to fit up the new factory site, which will add another fertilizer manufactory to Jacksonville's already large list of fertilizer factories. It is conservatively estimated that the company will do between 80,000 and 100,000 tons of business a year.

TAMPA.—Announcement is made by the Florida Brewing Company that in the very near future its big plant will be converted into a large sugar refinery. The plans of the company are only tentative. This city is a logical place to manufacture sugar as it is close to markets in Cuba from which much raw sugar is imported here by the United States.

Idaho

TWIN FALLS.—The Hercules Nitrate Company, with offices here, has been incorporated by O. A. Mathews and J. H. Mathews, to develop large deposit of nitrate in Malheur County, Oregon. The corporation has acquired control of 1280 acres, which is said to be highly impregnated with potash and sodium nitrates, magnesium sulphate and other chemicals.

Illinois

CHICAGO.—The Liquid Carbonic Company has had plans prepared for the erection of a one-story brick addition, about 50 x 200 ft., to its plant at Thirty-first and Kedzie Streets, to cost about $35,000.

CHICAGO.—The Victor Chemical Company, manufacturer of chemicals, has commenced the construction of a one-story power house, about 60 x 220 ft., for works operation, at its plant at Chicago Heights.

EAST ST. LOUIS.—The Monsanto Chemical Company, St. Louis, Mo., has acquired about 90 acres of property at East St. Louis, and is planning for the construction of a plant for the manufacture of chemicals. It is said the works will employ about 500 hands for initial operations.

Maryland

BALTIMORE.—The work of constructing a pipe line more than one mile long from the plant of the Curtis Bay Chemical Company at Stone House Cove to the Curtis Bay Distillery at Curtis Bay has begun. The line will be used to carry refuse from molasses after it has been used in manufacturing alcohol to the distillery, where it is to be converted into various products. When the distillery first opened the refuse was thrown away, but now it is being utilized at the chemical plant, until recently devoted to the manufacture of acetone. A right of way has been secured for the pipe line through the various industrial plants in the section and also through the yards of the Baltimore & Ohio Railroad. The refuse will flow by gravity, no pumps being used. It will be pumped into a high storage tank at the distillery. Just now it is being taken to the chemical plant in tank cars.

Massachusetts

MILLBURY.—The Millbury Steel Foundry Company has just awarded E. D. Ward, general contractor of Worcester, the contract for extensive additions to its plant on Howe Avenue, which will mean trebling its production and doubling its working force.

Michigan

DETROIT.—A despatch from Detroit says that the Henry Ford & Son Company has let to the George A. Fuller Company a contract for building blast furnaces on the River Rouge, near there. The cost will be $20,000,000, of which $8,000,000 will be spent for labor. Later a mammoth tractor plant will be developed. The furnaces with a capacity of 1000 tons daily will furnish all the iron and steel used both in Ford cars and in the tractors.

Montana

BAKER.—Gas Products Company, according to R. H. Deebach, manager, plans erection of a plant in Baker for the manufacture of carbon black. First unit will consist of eight sheds, and will produce 3000 lb. annually, the plant to be enlarged later to produce 24,000 lb.

MALTA.—It is stated that a fiber flax mill may be constructed in this city by the Havre Flax Mills Company.

New Jersey

NEWARK.—The Balbach Smelting & Refining Company, 380 Market Street, is planning for the erection of a new two-story addition at Hamburg Place and Curry Street, to cost about $8,000.

NEWARK.—The F. W. Devoe & C. T. Raynolds Company, 223 New Jersey Railroad Avenue, has awarded a contract for the construction of a new one-story brick addition to its plant. Henry M. Doremus Company, 36 Orange Street, Newark, is the contractor.

NEWARK. — The Butterworth-Judson Corporation, Avenue R, is having plans prepared for the construction of one and two-story additions to its plant, brick and steel, about 45 x 325 ft., and 69 x 225 ft., respectively, to cost approximately $125,000.

NEWARK.—The Metal Products Company, 790 Broad Street, manufacturer of twist drills and allied products, has announced the removal of its office to 32 Broadway, New York.

JERSEY CITY.—The Seydel Manufacturing Company, 88 Forest Street, manufacturer of chemicals, has had plans prepared for the construction of a new two-story manufacturing plant, about 80 x 170 ft.

JERSEY CITY.—The William T. Baker Company, Inc., 147 Pacific Avenue, has had plans prepared for the construction of a one-story reinforced-concrete addition, about 60 x 100 ft., to its varnish manufacturing plant. The structure is estimated to cost about $20,000. James Mitchell, Inc., 76 Montgomery Street, Jersey City, is the contractor.

PERTH AMBOY.—The Raritan Copper Company, foot of Elm Street, is building a new two-story addition to its plant, about 40 x 100 ft.

CLIFTON.—Fire recently destroyed a portion of the plant of the M. J. Levine Company, Main Avenue, manufacturer of aeroplane varnish, waterproofing materials, etc., with loss estimated at $30,000.

HILLSIDE.—Riches, River & Company, 30 Church Street, New York, manufacturers of chemicals, have had plans prepared for the erection of a one and two-story local plant, about 75 x 100 ft. Taylor & Mosley, 40 Wall Street, New York, are the architects.

ELIZABETH.—Fire recently destroyed a portion of the plant of the Bayway Chemical Company, with loss estimated at $10,000. It is said the structure will be rebuilt.

BAYONNE.—The National Sulphur Company has taken out a building permit for the construction of a one-story addition to its plant at Constable Hook.

PATERSON.—The Commonwealth Chemical Corporation of New York will erect soon at East Forty-second and Forty-third Streets, Paterson, a plant to cost more than $100,000. The city of Paterson held title to the property because of unpaid taxes of $3,347.36. The Paterson Board of Finance has agreed to deed it to the corporation on the payment of the taxes, upon the condition that it erect a plant costing not less than $100,000, work on its construction to commence within six months.

New York

NIAGARA FALLS.—The Niagara Alkali Company is preparing plans for a new $30,000 benzol plant. The company last week increased its capitalization from $1,750,000 to $5,000,000. The company has recently made several additions to its plant.

MICHIGAN FALLS.—The City Council granted the application of the Hydro Fats, Inc., of Buffalo to locate on a tract of Buffalo Avenue land owned by the Niagara Falls Power Company for the purpose of manufacturing edible fats from cocoanut oils. The company expects to obtain hydrogen from the Hooker Electrochemical Co.

LONG ISLAND CITY.—The Patterson-Sargent Company, Wason and Hamilton Streets, Cleveland, Ohio, has purchased a plot of 14,000 sq. ft. at Van Dam Street and Hunterspoint Avenue, and is having plans prepared for the erection of a five-story reinforced concrete factory building, for paint and varnish manufacture.

NEW YORK.—The American Can Company, 120 Broadway, will build a new two-story addition to its works on McWhorter Street, Newark, N. J. The structure will be about 50 x 120 ft.

POTSDAM.—The Racquette River Paper Company, manufacturer of paper, has awarded a contract to H. Wales Lyons, New London, Conn., for the construction of a two-story brick and reinforced-concrete addition to its plant, about 100 x 150 ft., to cost about $25,000. George Sisson is president of the company.

NEW YORK.—The Burns Manufacturing Company, 25 Beaver Street, manufacturer of chemicals, is planning for the erection of a new plant on Paterson Plank Road, East Rutherford, N. J.

Ohio

CLEVELAND.—The Ohio Bronze Powder Company, 1120 East 152d Street, has increased its capital stock from $50,000 to $200,000 for the purpose of increasing its capacity. The company manufactures a complete line of gold and aluminium products. Purchase of new machinery will take place this fall and work will begin in the spring on a two-story building, 30 x 100 ft., that will contain offices and a warehouse. The company owns a piece of land 80 x 400 ft., supplied with an industrial spur from the Nickel Plate.

TOLEDO.—The Burt Foundry Company, 934 Hastings Street, has secured a building permit to erect a $32,500 foundry addition on Bush Street, near the W. & L. R. R. Plant will be 200 x 200 ft.

Oklahoma

BAXTER.—The Crescent Lead & Zinc Company, which has several leases south of Baxter, Okla., has recently leased a portion of its land to a company that plans the immediate construction of a new tailing mill. An investigation of some of the chat piles that were left when different companies operated the ground a number of years ago is said to show a good blende content in the chats which it was impossible to obtain by former inefficient methods of concentration.

Oregon

PORTLAND.—The Western Reduction Company, Twenty-fourth Street and Nicolai Avenue, Portland, Ore., is building a plant and installing equipment for a ferro-alloy smelter. The building is 100 ft. by 50 ft., with a 100-ft. addition to go up as soon as the present work is completed. There are three electric furnaces to be installed now, making a total capacity about ten tons per day. The company will make ferro-manganese, using a Japanese ore. The furnaces are of local construction. Mr. A. T. Coakley is the metallurgist in charge.

VALE.—American Mineral Products Company is completing plans for its proposed nitrate plant at this point, to cost $40,000. Company controls nitrate deposits over 2500 acres, said to be from 50 to 60 ft. deep and average 3 per cent nitrate. Capacity of the proposed plant will be 200 tons daily, producing six tons daily of the commercial product.

ROSEBURG.—The Umpqua Copper Company has been incorporated in this city, to continue development work on eight mining claims in Douglas County. More than $25,000 has been spent thus far in development.

Pennsylvania

SHARON.—Improvements costing close to $3,000,000 will probably be completed at Farrell works of the Steel Corporation within 60 days. Improvements include 10 hot mills, new power plant, new ore bridges and bins at blast furnace and a modern bar mill. The skelp mill also was rebuilt.

PHILADELPHIA.—Fire recently destroyed a portion of the plant of George D. Wetherill & Company, 114 North Front Street, manufacturers of paints and varnishes, with loss estimated at about $50,000. The plant will be immediately rebuilt.

PHILADELPHIA.—The Pecora Paint Company, Fourth and Venango Streets, manufacturer of paints, varnishes, etc., has had plans prepared for the erection of additions to its plant.

DAHOGA.—Fire recently destroyed the stillhouse of the McKean Chemical Company, with loss estimated at $90,000. Headquarters of the company, which specializes in the production of wood alcohol and acetate of lime, are at 112 West Fourth Street, Williamsport.

CARLISLE.—The Carlisle Tire & Rubber Company is planning the immediate installation of machinery and equipment in the local factory building recently leased for the manufacture of its products. Charles S. Mooney heads the company.

WILLIAMSPORT.—The Lycoming Rubber Company has awarded a contract for the construction of a three-story addition, about 48 x 50 ft., to its plant on Rose

Street, near Erie Avenue, to cost about $10,000. Jacob Gehron, 1228 Ann Street, Williamsport, has the contract for erection.

POTTSTOWN.—The Light Manufacturing & Foundry Company, manufacturer of aluminium ware, is planning for the construction of an addition to its plant to increase the capacity.

Texas

HOUSTON.—The Simms-Sinclair oil interests have paid the sum of $289,681 for a 712-acre tract on the Ship Channel below the Turning Basin. For months these interests have been seeking a refinery site in the vicinity of Houston.

TEXAS CITY.—Work has begun on a grease plant at the refinery of the Pierce-Fordyce Oil Association at Texas City for the manufacture of all grades of lubricants and greases. The installation of the machinery and the instruction of the men who are to operate the new plant are under the direct supervision of J. H. Brinkmeyer of St. Louis, who was sent from the plant of the Pierce Oil Corporation in that city.

Utah

OGDEN.—Construction of a plant for milling zinc and lead ores by the Lake View Mining Company at Promontory Point has been arranged for by directors of the corporation, who made an agreement with A. O. Zimm of Los Angeles for the installation, which will cost approximately $20,000.

Virginia

IVANHOE.—The National Carbide Company, incorporated with $350,000 capital stock, has purchased a site of twenty-two acres, a little over a mile from this place, and will commence at once on the construction of an immense plant for the manufacture of carbide and for burning agricultural lime. Contracts have been signed up for the building of the plant and also for the larger part of the machinery to be installed therein. Large lime quarries have been leased, and there will be no delay in setting the plant to work when the buildings are ready.

Washington

SEATTLE.—The West Coast Chemical Company, with Phillips A. Carleton, president, and George N. Calkins, secretary-treasurer, has recently purchased 200 acres of coal lands near Cumberland, Wash. Company plans extensive additions to its chemical plant in Seattle, and the erection of a large plant for the manufacture of coal tar by-products. The company is the only manufacturer of the by-products of coal tar on the Pacific coast, and the new plant at Cumberland will be second of that kind in this section. The company's present plant, of which the manufacture of dyes is the most important branch has rapidly increased in importance since the European war. President Carleton states that with the expansion of the present plant, and opening of the proposed plant at Cumberland, between 400 and 500 men will be employed at the mines, and the force at the Seattle plant will be increased from 35 to several hundred.

SEATTLE.—The Olympic Portland Cement Company, here, will construct a coal handling plant at its cement mills in Bellingham, Wash., to cost $20,000. Plant will have capacity of 150 tons daily, as the oil fuel boilers will be converted into powdered coal burners.

SPOKANE.—Commonwealth Mining Company, operating near Hayden Lake, Idaho, will erect a concentrating plant, the first unit to have capacity of 60 tons. An 80-hp. boiler and four drill compressor will be a part of the new equipment.

WENATCHEE.—American Mill & Produce Company are developing the silica industry in Grant County. The concern recently acquired lease on a half section of state land, and have fitted up a plant to manufacture finished products.

NORTHPORT.—Northport Power & Light Company has recently incorporated for the purpose of supplying electrical energy to the Northport Smelting & Refining Company, and to mining concerns in the district north of Spokane. The electric power will succeed steam at the Northport smelter, which plans to extend its operations.

VALLEY.—The Northwest Magnesite Company, here, will shortly place its manufacturing department in commission. The company's plant investment represents $26,000, and will be used to refine magnesite and manufacture magnesite specialties. Shipments for each month are showing gradual increase.

IRONDALE.—After an idleness of five years, the blast furnace at Irondale, a remnant of the steel mills of the defunct Western Steel Corporation, has been placed in operation by the Pacific Coast Steel Company. The rolling mills of the old company have been removed by the Pacific Coast Steel Company to its plant in Youngstown. The Irondale furnace will employ 75 men, and will use for the present, the Chinese ore brought from China by the Western Steel Corporation. It is stated that later on local ore will be used.

SEATTLE.—West Coast Tanning Company, with a plant at 1138 West Sixty-fourth Street, Seattle, has been re-incorporated as the North Coast Tanning Company, and important extensions will be made to the company's plant. J. C. Ford, managing director.

Manufacturers' Catalogs

LINK-BELT COMPANY, Chicago, Ill., has issued a pamphlet on "Casings for Link-Belt Silent Chain Drives," describing silent chains.

LINK-BELT COMPANY, Chicago, Ill., has issued a pamphlet on "Link-Belt Electric Hoists," describing construction and operation.

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "The Worthington Steam Pump," describing outside packed plunger pattern pumps, for general service.

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "Worthington Volute Centrifugal Pumps."

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "Worthington Turbine Pumps for High Head Service," describing the turbine pump and principle of operation.

BRAEMER AIR CONDITIONING CORPORATION, Philadelphia, Pa., has issued a pamphlet on "Braemer Humidifiers and Dehumidifiers," describing air conditioning apparatus for industrial processes of every description.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has issued a pamphlet on "Westinghouse Synchronous Motors," describing power factor correction.

AUTOMATIC SPRINKLER CO. OF AMERICA, 123 William Street, New York, N. Y., has issued a pamphlet entitled the "Pursuit of Safety."

SHARPLES SPECIALTY COMPANY, West Chester, Pa., has issued a pamphlet on "Super-Centrifugal Treatment of Varnish," describing labor, force, cost, capacities, installation.

THE OLIVER CONTINUOUS FILTER CO., San Francisco, Cal., has issued a pamphlet on "Olive Filters," describing use, construction, operation.

N. Y. REVOLVING PORTABLE ELEVATOR CO., Jersey City, N. J., has issued a pamphlet on "The Steel Giant" elevator.

THE BRAUM CORPORATION, Los Angeles, Cal., has issued pamphlets on "Iron Ore, Crushers, Cement Laboratory Equipment, and Coal Testing Laboratory Equipment."

REPUBLIC FLOW METERS CO., Chicago, Ill., has issued a pamphlet "Human Weakness vs. Machine Accuracy."

Other New Publications

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FELDSPAR IN 1916. By Frank J. Katz, U. S. Geological Survey. Washington Government Printing Office. Published Aug. 25, 1917.

GRAPHITE IN 1916. By Henry R. Ferguson, U. S. Geological Survey. Washington Government Printing Office, 1917. Published Aug. 13, 1917.

CREOSOTED WOOD STAVE PIPE AND ITS EFFECT UPON WATER FOR DOMESTIC AND IRRIGATION USES IN 1917. By H. K. Benson. Prepared under a co-operative agreement between the Bureau of Industrial Research, the Forest Products Laboratory of the University of Washington, the West Coast Lumberman's Association, the Association of Creosoting Companies of the Pacific Coast, the Water and Engineering Departments of the City of Seattle, the Pacific Coast Pipe Company, and the Pacific Creosoting Company. Published by the University of Washington.

Manufacturers' Notes

CASTNER CHANGES HANDS.—The Mathieson Alkali Works, Inc., of Saltville, Va., has taken over the Castner Electrolytic Alkali Co., of Niagara Falls, N. Y., and the plant will hereafter be known as the Niagara Works of the Mathieson Alkali Works, Inc.

NEW JERSEY ZINC BUYS OFFICE SITE.—The New Jersey Zinc Co., whose present office is at 55 Wall Street, New York, is negotiating for a block between Maiden Lane, Front, Fletcher and Water Streets as a site for a new office building, seven stories high. Several parcels of the block are understood to have been already acquired and negotiations are under way for the remainder.

JAPANNING AND DRYING OVENS.—The Bradford-Ackermann Corporation, Forty-second Street Building, New York City, announce that they have been appointed the Eastern Sales Office for Young Brothers Company, Detroit, Mich.

The sale of Young ovens, for japanning and drying purposes, will in the future be handled by this eastern office for the New England States, New York, New Jersey, Maryland, Delaware and eastern Pennsylvania. An engineering department will likewise be available for manufacturers in the East who are interested in quick drying and baking processes, and special oven designs will be offered to meet various requirements.

THE STANDARD ASPHALT & REFINING COMPANY of Chicago, Ill., has purchased the plants, trade marks and good will of the Sarco Petroleum Products Company. The Cities Service Company of 60 Wall Street, New York City, is the new interest in back of this company, although the management remains essentially the same as before the change.

Mr. Charles Muller, who was an executive of the former company, now becomes manager. He has been associated with the old company for ten years and has risen through the ranks to his present position and is well known in business and financial circles in Chicago.

Mr. Robert F. Trumbull has been promoted to manager of the Railway and Building Materials Department. He has been in the service of the old company for eight years in this department. By constant contact with the trade during that time he is intimately acquainted with its requirements for asphalt materials.

WORTHINGTON PUMP & MACHINERY CORPORATION announces the opening of a new branch sales office at American Trust and Savings Bank Building, Birmingham, Ala., to take care of a portion of the very large territory hitherto controlled by the Atlanta Office. Mr. Edward Stauverman, formerly with the Atlanta office, will be in charge of the Birmingham office as manager. The territory controlled by the Birmingham office will be of all the State of Alabama, excepting the following counties: Choctaw, Clark, Monroe, Washington, Conecuh, Mobile, Baldwin and Escambia. All of the State of Florida, excepting the following counties: Okaloosa, Escambia and Santa Rosa. All of that portion of the State of Georgia south of the Seaboard Air Line, running from Columbus, Ga., to Savannah, Ga.

All inquiries originating in this territory should hereafter be addressed to the Birmingham office, located at American Trust & Savings Bank Building, instead of to Atlanta, as heretofore.

The States of North and South Carolina and that portion of Georgia north of the Seaboard Air Line will continue to be served by the Atlanta office under the management of Mr. A. W. Jones.

SOYA BEAN OIL.—A special freight train consisting of twenty-seven tank cars of soya bean oil left the Pacific Coast on Sept. 22 for the East via the Union Pacific Railroad. This is stated to set a new record for single shipments of soya bean oil. The shipment is consigned to Marden, Orth & Hastings Corporation, 61 Broadway, New York.

Metallurgical and Chemical Engineering

A Consolidation of
ELECTROCHEMICAL AND METALLURGICAL INDUSTRY and IRON AND STEEL MAGAZINE

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Doctor Roeber

A quiet funeral in a little house in East Orange, the body of its gentle master at rest among flowers in the parlor, the conventional service of death and the benediction—and the leaf of the big book was turned. Just a few words in ecclesiastical monotone—and everything so different. The machinery mumbles on, the presses revolve, the paper is whisked back and forth in the manner appointed, everything proceeds as before, but somehow the heart of it is still, and all the rest of us, major and minor parts of the organization, are benumbed for the time. We are catching our breath for a fresh start. Of course, the paper will continue; it will look the same and serve the same purpose, because it was planned unto whatever merit it has by one who had a great gift for this very thing.

Now let us consider what manner of man this was, who infused so strong a personality into his editorial work that the paper was almost as frequently spoken of as "Roeber's Journal" as by its printed title. Although he occupied posts of distinction, had been president of the American Electrochemical Society, of which he was one of the founders, and associated with many men of high repute on important committees, his acquaintance among men was far slighter than his influence over them. This was in part because his influence was widespread and in part because of his unusual modesty and extraordinary sensitiveness, which he had in greater measure than was compatible with comfort.

He was a little, round man with a round chin, round spectacles and a big round hat designed for a Texas sombrero, but which on his head straightway became *ein Professorenhut*. He was German born—anybody could see that—but his was the kind that those of us who knew Germany best before the war still love despite everything. And he was a thoroughly sound, patriotic, loyal American citizen without any reservation. He believed in everybody, had faith in everybody and a good word for everybody. There was such kindliness and goodwill in his greeting, in his unflinching, believing, encouraging look that the very thought that those gentle blue eyes are dimmed for all time bites into the heart.

The man on the street or in the railway car did not know these things, and so sometimes he was taken for an enemy alien—our editor—whose father and grandfather had opposed Prussianism all their lives and who himself had left Germany because of it. But the slightest unfriendly glance, or the tone of a word spoken in scorn were enough to give him acute pain. Rarely have we known a mortal with such hair-trigger sensitiveness. Nevertheless, he would not let it hinder

him from digging into the day's work or from bearing the sting of it in silence. We verily believe that this shortened his life.

In his office, at his desk, he was a different man. There command was easy to him and there was no hesitation in his decisions. When well-wishers urged him to avoid printing articles with mathematical developments beyond the reach of most readers, he would smile, shake his head—and print in full. If a fair word about labor might offend someone who had neglected to provide for the life, liberty and pursuit of happiness of employees, he would chuckle—and print it. Neither conventional ethics nor philosophy frightened him. He edited a technical paper, but he never forgot the human factor in applied science and industry. When he felt that something needed to be said, he had no interest in minor consequences. He had confidence in his own wisdom, and Wisdom herself was justified in him. He was gracious in receiving advice, but independent in his conclusions. To think or to decide—and decide aright—was neither hard nor painful to him. He was a master at his profession and he breathed the breath of life into his work.

In taking up the burden that has fallen from his shoulders, the editors and publishers are not concerned about articles, or their arrangement, or about comment on things of interest, or advertisements, for these are all provided for. The burden of our hope is that we may attain the same at-homeness in the work and the same cordial goodwill of our readers that the late Dr. Roeber both won and enjoyed. Peace to his memory.

Société de Chimie Industrielle

During the present international complications it is essential that we should not be so preoccupied with problems demanding immediate solution as to lose perspective of our future industrial life. It is a time for the encouragement of forward-looking movements that are concerned with post-war conditions and with the inevitable readjustment that will then take place in international life. And what more logical development than that the bonds of mutual interest in times of peace be most firmly cemented among the nations now allied in common military defense?

Since the entrance of the United States into the war we have received and entertained a number of missions from the allied European countries sent here for the purpose of study. Of these none has been more graciously received than the French Scientific Mission, which is here to investigate our chemical industries and impart as well as receive information and advice. France having realized fully the importance of chemistry in the war, the progress which her enemy neighbor has made in the science and her own loss of the position of honor therein which she formerly occupied, has determined to regain her place and again become a great national exponent of industrial chemistry.

To this end her leading scientists have recently organized the Société de Chimie Industrielle, similar in purpose to the better known Society of Chemical Industry in England. With the arrival of the French Scientific Mission in this country, some of our chemists were inspired with a patriotic desire to forward the French movement by organizing an American Section of the Société, and thus lay the foundation for future profitable intercourse.

If we read the future aright, French is to be an important language to the progressive American industrial chemist, and French chemical literature will be an exponent of progress. American chemists in increasing numbers will find congenial employment in France, and the relations of the two nations will be enhanced by intimate association with the Société. It remains for us on this side to promote the solidarity of the profession by ardent support of the new organization.

High Prices and Production

It is gradually dawning upon the consciousness of the average American that the present high prices of all commodities are by no means stimulating production in the heralded volume. Prices for coal, for instance, have been fixed at figures quite exorbitant if viewed from the pre-war standpoint, and yet the Geological Survey is recording a practically stationary production, and the newspapers report stories of fuel famines. As noted elsewhere in this issue, Joplin mines which formerly were profitable on $40 ore, were closed when ore recently declined to $70. Copper production has been seriously curtailed even though its price has been above 23½ cents for months. The relation of output to price at times even seems to follow that curious anomaly in the labor market; that is, the higher the daily wage the lower the production per man-hour.

The reason is not so very obscure. High commodity prices mean economy in consumption and waste in production, while low commodity prices mean the opposite. With high prices the ultimate consumer gets along with less than he really needs, and even then his finances can hardly bear the strain; the manufacturer at the same time need make no effort to produce in an economical manner, for the price he receives for his output will cover a multitude of sins of omission and commission, and even then leave a very encouraging cash balance. That is to say, they did! To-day, however, all his fellow-producers have gone and done likewise; all his low-priced stock of raw materials and repair parts is exhausted; his total expense for labor, everything, is increasing so rapidly that it overtops the income; a red figure appears on the balance sheet, and the factory closes.

Is it not that America needs a spiritual awakening? War is a hard taskmaster, and yet Mars may furnish the leaven which in time will ferment the entire body. For there are countless young men now serving their country, leaving behind their positions, their salaries, their hopes for preferment—everything that seems best to them. Money means little to them now; it will

mean less ere they happily return. May they come back fire-refined, with a purer and better outlook and more stable sense of the eternal fitness of things, to instruct the stay-at-homes by their noble example.

Future of Iron and Steel Prices

A measure of price control has now been established for the iron and steel industry. It has been accomplished by agreement between the Government and the producers. Specific maximum prices have been set for certain products, while there is an understanding that prices for other commodities are expected to be adjusted to the same general basis by voluntary action on the part of producers.

It is not difficult to compare the price level as established or being established with average prices of the past, for the reason that average prices over various periods of years have not varied greatly. The iron and steel market has had great ups and downs, but the round trip movement has been confined to relatively short periods, and there are various periods of years, long and short, that have shown substantially the same average. A fair representative period is the ten years, 1904 to 1913, inclusive, containing about the usual sprinkling of good and bad years, and showing averages not greatly different from those of many other periods. Generally speaking, the new prices are just a trifle more than double the average prices in that period. Unfinished steel is a trifle less, but pig iron is about 110 per cent higher and the finished steel products average about the same amount.

The transition from the open market, with extremely fancy prices produced by buyers bidding against each other for relatively small prompt lots, to a more or less regulated and a much better defined market, has proceeded with much less confusion than might have been expected. It occurred, fortunately, at a time when the market was extremely dull and there was not much disposition to do business.

With this transition largely accomplished the trade has turned quickly to a consideration of the question, what is to be the trend of steel prices in the future. The first price announcements at Washington specifically stated that the set prices were subject to modification Jan. 1, 1918. It is the common view of the trade that if the market level changes in future the change will be downwards. The Government might, in accordance with its suggestion, set lower prices on Jan. 1, or later, or the market might of its own accord decline to lower levels, as, of course, the prescribed prices are maximum only. However, the steel trade has had a great deal of experience in the past in adhering to certain prices, once fixed. It was illegal for the makers to meet and adopt prices, or even to agree to maintain prices, but when prices were well established there was nothing to prevent the producers, acting as individuals, from departing from the established schedule. It appears to be the common idea that if the steel market should develop some weakness as to the relation between supplies and requirements, the producers would be slow to depart from the established maximum figures, but would hold to them as long as possible.

It is almost inconceivable that conditions in the United States as to steel should conform to those developed in England after more than three years of war. England has been converted into a vast arsenal. There is practically no peace steel being manufactured. England, however, is producing about 8,000,000 tons of finished rolled steel a year, while the United States is producing four times as much. England is supplying France to a very considerable extent, the French steel production being only in the neighborhood of one-half the British production. With such indices as to the war-steel requirements of great nations it is difficult to see how the United States can find means of employing its very much larger steel production entirely for war purposes. The means for converting the steel, as it leaves the steel mill, into the various means for prosecuting war must be found. It is a question between the prosecution of war calling for steel and the prosecution of war decreasing the peace consumption of steel.

The more the country at large devotes itself to war, in consuming or fabricating steel for that purpose, the more it leaves the arts of peace that consume steel. One thing is obvious, and it may prove to be the governing factor in determining the relation, a few months hence, between the supply of steel and the requirements, and that is that the railroads are always a necessary and great factor in determining the requirements that are put upon the steel industry. Without fairly heavy buying on the part of the railroads the steel industry is never active. Certainly, when the full prosecution of the war depends so much upon full transportation facilities being maintained, one could not imagine a condition of the railroads not taking steel and other consuming industries taking it freely.

The position of the railroads is particularly in doubt at this time. They have been handling a vastly greater volume of freight than ever before in their history, with practically no larger amount of rolling stock than at any previous time. Winter, however, is approaching and in bad weather the effectiveness of railway facilities always decreases. The railroads, apparently, are not in mood to buy at present prices, even though they represent a substantial reduction, for they are still at least double the previous average. The 15 per cent rate advance case is reopened, with hearings to begin before the Interstate Commerce Commission on November 5. The large question, whether the commission will consider it in that form or not, is whether the gold dollar has greatly depreciated. If it has, then railway rates being fixed in dollars ought to be advanced, for wages and commodities generally have advanced. A substantial rate advance may be granted, while there is an alternative suggested, that the Government undertake to finance the railroads. Many railroad managers, however, explain very practically that what they want to do is to make money, not borrow it.

Eugene Franz Roeber

DR. E. F. ROEBER, editor of METALLURGICAL & CHEMICAL ENGINEERING, died at his home in East Orange, N. J., Oct. 17, 1917, after a lingering illness of several months. He had not enjoyed the best of health for a year or more, but it was not until last June that he was compelled to leave his work, to which he never returned. For some time it was hoped that complete relief from care and responsibility, coupled with the best of medical care and attention, would restore him to health and activity, but he failed steadily, and came to an untimely end in the prime of life.

DR. ROEBER was born in Torgau, Saxony, Oct. 7, 1867, and passed his fiftieth birthday ten days prior to his death. His excellent education in science and engineering was received at three German universities, Jena, Halle and Berlin. At the last institution he received the degree of Doctor of Philosophy in 1892. Without waiting to find a field for his abilities in his native country, he came to the United States in 1894. For several years he remained in comparative obscurity, and for part of that time at least was associated with the book concern of Steiger in New York.

In 1899 he made the acquaintance of Dr. Carl Hering of Philadelphia, who engaged him as an assistant, and he removed to Philadelphia. This was his first professional engagement, and marked the beginning of a notable career in electrochemistry which led to his recognition as a leader. His work was characteristically thorough, reliable and conscientious, qualities which he later applied with such success as a technical editor, and which first became apparent in his digest of foreign literature for the *Electrical World*, published in New York.

The early days in Philadelphia witnessed two important undertakings in which DR. ROEBER played an important part. It was then that electrochemistry was assuming an aspect of importance in this country, and the time seemed opportune to publish a journalistic exponent for the industry. Accordingly, *Electrochemical Industry* was established as a monthly publication in September, 1902, with DR. ROEBER as editor. It was edited at Philadelphia until June, 1903, when the office was removed to New York. Under his editorial guidance the magazine grew in importance and influence, and in January, 1905, it assumed a broader field of activity under the title *Electrochemical and Metallurgical Industry*. In 1906 came the absorption of the *Iron and Steel Magazine*, and in January, 1910, there was a further expansion of the field served by the magazine to include the general realm indicated by the present title, METALLURGICAL AND CHEMICAL ENGINEERING. Through all of these logical developments DR. ROEBER remained as editor, directing the policies and enlarging the field of service of the magazine which stands as a fitting tribute to his ability.

The other project, initiated in Philadelphia about the same time, was the organization of the American Electrochemical Society. This developed from the close association of DR. ROEBER with C. J. Reed, Carl Hering and others, and had its inception in the informal gatherings and discussions of that group. DR. ROEBER'S enthusiasm and encouragement in the organization and continued support of that society was responsible in large measure for its success and present influence. It must now be a matter of gratification to its members to know that they honored him with the presidency in 1913-14.

He had a wide interest in science and engineering and a broad knowledge of both. This, coupled with an unusual ability to express himself in a pleasing literary style, gave his own writings a tone of authority and confidence, and enabled him to choose wisely from the contributions of others. In speech, his English was broken, but in writing it was exact and fluent. This was because he early recognized the demand which the editorial profession made upon him, and he applied himself to it with characteristic thoroughness. His services, therefore, were in demand by publication committees and library boards of several technical societies. His wide interest in science and engineering was evidenced by membership in the American Electrochemical Society, American Institute of Mining Engi-

neers, American Chemical Society, American Institute of Electrical Engineers, American Institute of Chemical Engineers, and Society of Chemical Industry. He was a member also of the Chemists' Club, New York.

The high personal regard in which he was held by his professional friends was evidenced in many ways, but probably with no more kindly and sincere token than the silver loving cup which was presented to him during his presidency of the American Electrochemical Society. This represented the loving tribute of a large number of friends and admirers throughout the country, who gladly responded to the proposal made by Dr. L. H. Baekeland.

While still living in Philadelphia, DR. ROEBER married Miss Clara H. Feir of New York, the ceremony being performed in Hoboken, N. J., May 6, 1900. He continued to make his home in Philadelphia until 1903, when he removed to New York. He is survived by his widow and three sons, Edward and Bert, aged 11, and Robert, aged 4.

Personal Tributes

BY CARL HERING

THE writer claims the honor of having "discovered" Dr. Roeber; it was in 1899, when he was doing clerical work in a book store in New York. He was a total stranger to me, but a few minutes' talk with him convinced me that he had an exceptionally good education and was a man of rare abilities, and I considered myself fortunate in being able to secure him as my assistant, which position he held until about 1903. It was his first professional position, he having only recently come to this country.

His excellent and thorough training in the fundamentals of physics in general, and electricity and electrochemistry in particular, encouraged us, in cooperation with Mr. Weaver and Mr. McGraw, to start the monthly journal, *Electrochemical Industry* (later METALLURGICAL AND CHEMICAL ENGINEERING) in September, 1902, making him the editor. It was edited for its first year from my office, and he was its able editor from that time to his death.

The highly interesting and instructive discussions on electrochemistry in the evenings with him and C. J. Reed led us to initiate the formation of the present national electrochemical society. Had it not been for his encouragement, both of these eminently successful ventures, the journal and the electrochemical society, might not have been started.

His work, even when difficult, could be relied upon absolutely, never requiring any supervision; he never made mistakes in his calculations. His unostentatious modesty gave one an incorrect impression of his latent abilities.

He was an indefatigable worker, conscientious and thorough to an extreme, always ready and willing to do hard work—the harder it was the more it interested him. His great ambition was to do his work well. It was his willingness to assume more work than his health warranted that led to the untimely ending of his career.

The final balance in which a completed life is weighed is one which measures the good which has been done during that life. In this balance his useful, prematurely terminated life outweighs that of many of his co-workers.

As a friend he was always true and loyal. Personally I feel that I have lost one of my highly esteemed and most valued personal friends.

Philadelphia, Pa.

BY ARTHUR D. LITTLE

THE death of Dr. E. F. Roeber at an age which connotes ripe experience and many years of prospective usefulness brings deep regret to all who knew him and is a real and serious misfortune to American science and technology. Great editors are rare in any department of intellectual activity. They are most exceptional among technologists, and Dr. Roeber was a great technical editor. He possessed the broad foundation of exact knowledge which gave weight to what he said, and the literary ability to say what he wished effectively. He had the sense of timeliness, the critical faculty for appraising values, and a fine enthusiasm which verified and rendered notable the publication under his control. He assumed his editorial duties at a time when applied chemistry in this country was peculiarly in need of encouragement and expression, and he discharged these duties so effectively and even brilliantly as to place all American technologists in his debt.

Dr. Roeber had a singularly sensitive and kindly nature which evoked response in all who came in contact with him and by them he will always be remembered with affection.

Boston, Mass.

BY WILDER D. BANCROFT

ROEBER'S career is a wonderful confirmation of the cherished belief that in America each man will somehow get a chance to develop his particular talents. When he came to this country he had in him the makings of a great editor; but it is doubtful whether he knew this, and it is certain that nobody else did. He happened to be associated with several of the men who founded the American Electrochemical Society, and when an enterprising publishing firm started *Electrochemical Industry* he was made editor of the new journal. It seemed probable at the time that he was expected to do the hard work and not to furnish the editorial brains; but this was his opportunity and he made the most of it. What he has done is written large for the world to read. We can only guess what he might have done had he been spared. To accomplish what he did required not only great ability, but a sterling character, and Roeber had both. The surviving members of the Electrochemical Society may well be thankful that they were able to show their appreciation of his work by electing him president.

Ithaca, N. Y.

BY JOSEPH W. RICHARDS

OUR beloved friend united the best qualities of German thoroughness with the finest sort of American enlightenment and progressiveness. It was an incomparable combination. He wrote such English in his editorials as is scarcely matched by the best technical writers; his style was admirable. And there breathed through all his writing a broad spirit of tolerance, brotherly kindness and helpfulness. On every question of present interest in chemistry and metallurgy he took a point of view which was inspiring to his co-workers and educative to the technical public.

And then his ability to get people to pull together; to induce them to impart their experience in written articles for the general benefit of the profession; his unerring judgment on the fitness and the timeliness of technical communications and discussions! For fifteen years chemistry and metallurgy, and particularly electrochemistry, have been accumulating a debt to his activity and personality which is second to its obligation to none other. Not only the United States and Canada, but Europe was his debtor. His beloved journal, the pride and the glory of his career, was better known (and possibly more appreciated) in Europe than in America. It was known as "Roeber's journal." What greater tribute can there be paid to his being the inspiring soul of this magnificent technical periodical. It is his monument, and will perpetuate his memory, his tireless energy, his wonderful assistance in the technical development of his adopted country, and in its leadership in world affairs. We can all regret the loss to the world of technical journalism which his death means, and deplore the cutting off of his activities, but we can just as sincerely and intensely rejoice that we had the stimulus of his leadership and the privilege of his comradeship during fifteen long and notable years—the best years which applied science has ever experienced.

South Bethlehem, Pa.

BY L. H. BAEKELAND

DR. Roeber appeared among us some seventeen years ago. Modest to the point of bashfulness, yet cheerful and enthusiastic, he soon became, through his abilities, knowledge and intense work, an active element among that group of men who set the ball rolling in the development of our electrochemical industries. This same group of men made of the American Electrochemical Society the great constructive organization which it is to-day.

He put his whole personality and talent in the editorship of METALLURGICAL AND CHEMICAL ENGINEERING, *née "Electrochemical Industry,"* but more fitly named by his friends by the shorter, unofficial title "Roeber's Magazine." One day he told me that his main aim in life was to build up his publication to be the best in its line. He most certainly succeeded in this, and erected his own monument thereby, teaching at the same time to others how to publish a journal of applied science. He showed the American Chemical Society along what lines it should publish the Journal of Industrial and Engineering Chemistry, which followed him as a guide and as a pace-maker.

In the meantime, he lived a modest life along the principles of plain living and high thinking, never putting his personal interests in the foreground, yet fearless and outspoken whenever it came to a matter of responsibility, duty or justice.

Whoever has known Roeber can never forget him; they also realize how the events of this war preyed on his mind and hastened his untimely end. A thorough lover of his adopted country, a firm believer in America's great mission for democracy, he suffered in silence at every crime perpetrated by those who are leading his native Germany into the Great Abyss. His friends respected his agonies and they saw in him another living argument that even modern Germany sent us some men whose souls are clean and free and generous.

Yonkers, N. Y.

BY W. R. WHITNEY

IN the death of Dr. Roeber, American electrochemists have lost one of the most forward-looking of their number. Active and constructive, agreeable and appreciative, he was most generally known and esteemed. In his quiet way he did a great deal toward establishing conditions of understanding between our scientists and our engineers. We know what service he gave to the American Electrochemical Society in its establishment and by never-tiring support, and we know how he built up his journal, METALLURGICAL AND CHEMICAL ENGINEERING. But these are only the general expressions which must come to the minds of thousands of American chemists.

To me personally, when I think of Dr. Roeber, these seem his minor points. We loved him heartily for the man we found in him. We never saw him when he was not ready to bubble over with enthusiasm in support of any good thing. He was independent in thought, but this never interfered with his good nature and co-operation. He kept his worries buried beneath a smile. Born in Germany, he was no less a loyal citizen of this country. The mental anguish which he must have felt during the past three years was seldom shown or expressed, but we know how he suffered, because we knew his highly sensitive and lovable make-up. This sad but successful trial of his character was greater than any of us can possibly appreciate, yet he never faltered. To me he was a perfect American citizen with a strong heart broken for his fatherland. We shall class him with those who, whether in arms or no, have proved themselves heroes.

Schenectady, N. Y.

Southern Meeting Planned for American Electrochemical Society

It is believed that unusual interest will attach to the meeting of the American Electrochemical Society in the spring of 1918 through the opportunity that will be afforded to visit the rapidly developing industrial centers of the South. Plans laid last week by the directors provide for a week's trip by special train through Tennessee and Alabama. The party will be organized at Washington, D. C., and one day will be spent in the vicinity of each of the following centers: Kingsport, Knoxville and Chattanooga, Tenn.; Sheffield and Birmingham, Ala.

Kingsport, Tenn., is a self-contained industrial center, manufacturing electrolytic chlorine, leather,

glass and dyestuffs. At Knoxville there will be an opportunity to see some new and important hydroelectric developments on a large scale. Chattanooga will be an interesting point on account of its waterpower development and possibilities, manufacture of ferrosilicon and the concentration and smelting of zinc ores.

One of the most interesting features will be a visit to Muscle Shoals at Sheffield, Ala., which is the site of the Government's new nitrate plant. Here there will be a hydroelectric development of 500,000 hp., with possibilities for a second development of equal magnitude. The visit to Birmingham will close the trip, and return to Washington will be made from that point. Birmingham is one of the most active Southern industrial centers and is notable for its natural resources in coal, lime and iron.

It is announced that the strongest and most influential forces of the South are taking an active interest in this meeting, and there is every prospect of a mutually profitable trip. The South will acquaint the society with its resources and opportunities, and the society will endeavor to show how those resources can best be utilized in developing electrochemical industry. Technical sessions will be planned for the evenings spent at the various centers.

Although this meeting as planned will be more pretentious and larger than any yet held, it is felt to be timely as well as affording an unexcelled opportunity to see a rapidly developing region of our country. It is anticipated that the expense will not much exceed the cost of transportation and Pullman service.

New York Section of Society of Chemical Industry

The first sectional meeting of the season in New York was held at the Chemists' Club on Friday evening, Oct. 19. It was a joint meeting of the New York Section of the Society of Chemical Industry with the New York Sections of the American Chemical Society and American Electrochemical Society. A dinner preceded the meeting, and a large number were present at both the dinner and the meeting.

Dr. JEROME ALEXANDER of the National Gum & Mica Co., chairman of the New York Section of the Society of Chemical Industry, presided. He opened the meeting with a few remarks on the war situation and the formation of an American section of the French Society of Chemical Industry, and then introduced Dr. M. C. WHITAKER, president of the Chemists' Club. Dr. Whitaker announced that at the last meeting of the club Prof. VICTOR GRIGNARD of the University of Nancy, France, had been elected an honorary member of the Chemists' Club. Dr. Whitaker then introduced Dr. L. H. BAEKELAND as the master of ceremonies in conferring the honor. Dr. Baekeland made a very impressive speech, mostly in French, in which he expressed to Prof. Grignard the great pleasure which it gave him to confer upon him the distinction. He said the French chemists had been too modest in advertising themselves in this country, to their own detriment. The audience rose in acknowledgment of its appreciation when Dr. Baekeland had finished. Professor Grignard responded with an excellent address in French, a translation of which is herewith given in full.

Prof. Grignard's Address

I feel truly perplexed before all the marks of sympathy, all the honors, which have come to me like an avalanche since I put my feet on this beautiful land of America.

From the moment I arrived, even on the ship itself, two of your eminent representatives, Dr. Baekeland and Professor Bogert, kindly put themselves at the disposal of Mr. Engel and myself and offered the hospitality of this house.

Since then, wherever we present ourselves, we have encountered the same enthusiastic welcome, the same sincere desire of being of service to us.

Then again, at the beginning of the month of August, a charming and memorable banquet, even more touching by its intimate cordiality than any great official galas which often are more arranged for the gallery than for the participants, brought us together in this same place.

Then again, that important meeting in Boston, where Professor Stieglitz announced so kindly the great honor which was conferred upon me by the American Chemical Society, and which has been appreciated as much as it was unexpected.

And to-day, gentlemen, you open to me all the big doors of your great house, you welcome me into the intimacy of your home; in a word, you adopt me as a member of your great family.

Let me tell you that this honor impresses me even more than the preceding ones, because there is in this something which touches me more particularly in a personal way.

Undoubtedly I am happy and proud to have been for you an occasion to manifest your sympathies, even your admiration, for France in general, and for French chemistry in particular, but, believe me, I would be less impressed when bringing home from here honor certificates and diplomas if I did not know I am taking home to my country also somewhat of your hearts.

This ceremony proves to me that I am not mistaken in this. Therefore, gentlemen, I desire to express more particularly my profound gratitude, my great happiness, to have been able, notwithstanding my lack of knowledge of the English language, to bring to you the impression that in spite of the sorrows of the present hour French chemistry, like all France, lives and works, and only desires to live and work still more. And we look upon our big American sister as particularly qualified to help us in this work of reconstruction.

Indeed, gentlemen, you possess all that is necessary for this. Thanks to the immensity of your magnificent territory, you have natural forces and mineral riches of the most varied nature, of greatest abundance, and of the most precious kind, which nature has been able to give to any people.

You have the confidence and enthusiasm of youth; you have also the audacity thereof, and fortune, which loves the audacious, smiles upon you. Have you not shown excellent proof of this in the creation and the prosperity of the Chemists' Club? You have banking organizations which know how to favor beginning enterprises; you do not allow yourself to be held back by timid men or by skeptics, and you know how to look forward on a large scale—large, like your beautiful land!

Many of your projects surpass by their audacity the limits of our immediate comprehension. Thus, it has frequently happened in France, at least in certain circles, to try to class such enterprises by saying "It is American bluff." But nothing of the kind. We have to admit it. The bluff resides merely in our imagination. It is not in yours; you look at the world in all the boldness of your imagination, and you dream of realities which sometimes seem to surpass the possibilities of the moment. You have the vision of grandeurs of the future—that is all. But do not let us call this bluff; let us admire it.

What can your older little sister bring you to complete such a powerful *ensemble?* Truly, very little; but, nevertheless, something! A finer sense of truly scientific ways, due to a tradition and an education of older duration; after all, the privilege of seniority is not always enviable, but it may often render its services.

France owes it to this that in many directions, and more particularly in chemistry, she was an innovatrix, and this privilege would have been still more obvious, even to the minds of those who are less informed, if our laboratory men, if our engineers, had had behind them sufficient backing, well equipped laboratories, more elastic budgets, well-informed manufacturers, daring capitalists.

Many new ideas which germinated in France might have grown up there, and might have contributed to make the halo of French science still more brilliant.

For instance, to speak of a question of burning reality, the synthesis of ammonia, which at this moment preoccupies all the Allies, the so-called Haber process is called thus because it has been studied and put in shape in the laboratory of Haber by a Frenchman, Rossignol. It is probable that if Rossignol had possessed in France a laboratory which afforded the resources of that of Haber, France would not be at this moment anxious to procure ammonia, and Germany might perhaps have been short of it long ago. Furthermore, the principle of this process, that is to say the combination of nitrogen and hydrogen under pressure at a sufficiently high temperature, and in presence of a catalyzer, was discovered a long time ago in Paris by our eminent chemist, Le Châtelier.

Unfortunately, the gaseous mixture at one of the tests was ill-prepared and still contained oxygen, and caused the explosion of the apparatus, and the experiments did not go further. We should not think, of course, that when an apparatus blows up it is the French scientist who retreats. No, alas! it is simply his budget which blows up.

And thus was it that the synthesis of ammonia, which ought to have been a French conquest, has taken the aspect of a German discovery.

Well! We know at present in what soil we shall have to plant the good seed. Whenever the old French humus will no longer be deep nor rich enough to permit a rapid and powerful growth, do not let us lose our way among our rapacious Eastern neighbors, who are always on the alert for some new plunder; let us take it to you where we shall find the confidence, the daring perseverance, with all the material and financial resources which can assure success.

In this way, long ago, the inventor of the triple-effect evaporator, when he was misunderstood in his own country, brought to your sugar refiners his ingenious discovery, which since then has had a splendid development in many industries. It is necessary that a close co-operation on scientific and industrial lines should be organized more and more between our two countries.

The horrible war which has been imposed upon us has already made a big step in that direction.

In order to save the world from Prussian hegemony, in order to stop the grasping hand of Germany over every liberal thought and generous instinct, we cannot have enough of the support of the United States alongside that of the European Allies. And this brotherhood of our armies has made indispensable, more particularly between our two countries, the scientific and industrial alliance which is necessary to conduct this war, a war more scientific than anyone ever imagined.

Without citing too many examples, our metallurgists have already brought to you precious improvements in the manufacture of steel; from your side, you bring us a solution, and perhaps two solutions, to the bothersome nitric acid problem.

This fecund collaboration should continue after our victory. Yesterday we exchanged professors; to-morrow we shall exchange students. Thanks to the zeal of my devoted collaborator, Engel, thanks to the friendly efforts of some among you, quite a number of American chemists have already subscribed their names for membership in the Société de Chimie Industrielle, which recently has been founded in Paris, and I hope that at our return to France, we shall be able to reciprocate and to increase the number of members of the American Chemical Society.

In this way the field shall have been well prepared for the exchange of ideas which will precede our common efforts.

In their own turn, other elements of intimate collaboration will present themselves to reinforce all that exists already, and if I am enabled, within a few years, to visit again your beautiful land, I have the firm conviction that I shall be able to bring then the greetings of a newer France to a still greater America.

* * * *

Mr. J. V. N. Dorr, of the Dorr Co., chairman of the New York Section of the American Electrochemical Society, then announced that Dr. E. F. Roeber, editor of Metallurgical & Chemical Engineering, had passed away, and spoke a few words of appreciation. He suggested that a committee of three be appointed to draw up resolutions. The suggestion was put in the form of a motion and passed. Dr. Doremus moved a rising tribute to Dr. Roeber, which was accordingly acted on.

An interesting technical program was presented, the first paper being read by W. L. Jordan of the Kieselgahr Co. of America on recent problems in filtration. He dwelt particularly on the uses of Filter-Cel in the filtration of oils, soaps, glycerine, etc.

Mr. Maximilian Toch, of Toch Bros., New York, gave an interesting account of an investigation on the pigments of the tomb of Perneb.

A description and practical demonstration of the Kober-Nephelometer was given by Mr. P. A. Kober of Albany, N. Y.

"Titanium and Its Industrial Applications was the subject of a short talk by A. J. Rossi, of the Titanium Alloys Mfg. Co., Niagara Falls, N. Y.

St. Louis Meeting American Institute of Mining Engineers

The latter part of the meeting, the first two days of which were reported in our last issue, page 455, consisted chiefly of an excursion through the zinc and oil fields in southwest Missouri and northeast Oklahoma. Here the local sections of the Institute outdid themselves in entertaining their visitors in every way possible. The coincidence of so many interesting inspection trips with the technical sessions, told heavily on the attendance at the latter. The iron and steel session held at St. Louis on the third day of the meeting was unfortunately attended by a mere handful.

IRON AND STEEL SESSION

Messrs. R. B. SOSMAN and J. C. HOSTETTER of the Geophysical Laboratory presented two papers on certain phases and inferences to be drawn from their studies on artificial and natural oxides of iron. These papers, which are of interest mainly to geologists, will scarcely bear abstracting in this place. They are but another of the remarkable scientific publications from the Carnegie Institution.

HENRY S. RAWDON of the Bureau of Standards read an interesting contribution on "Some Unusual Features in the Microstructure of Wrought Iron." He pointed out that the usual commercial iron contains varying amounts of phosphorus and silicon in solid solution in the ferrite, and the remaining impurities—manganese, silica and sulphur—exist as slag inclusions. The ferrite matrix has the microstructure and appearance of a pure metal, and deep etching reveals nothing but etching pits. In examining a number of wrought iron samples known to be "unsatisfactory," a few of them showed areas of large ferrite crystals of a peculiar mottled appearance, particularly after prolonged etching with 5 to 10 per cent alcoholic solution of nitric acid, or more readily with Stead's reagent (*Journal* of the Iron & Steel Institute, vol. 91, p. 140). By a study of iron-phosphorus alloys this is shown to be caused by non-homogeneous diffusion of the phosphorus into the solid solution. Prolonged heating is necessary to cause a uniform distribution. The fracture of a certain wrought iron eye-bar followed a course nearly parallel to these phosphorus etch-patterns, and an examination of the adjacent metal showed the characteristic slip planes developed by alternating stresses. The effect of the brittle phosphoric ferrite is apparent.

EXCURSION TO MISSOURI AND OKLAHOMA

Wednesday evening, Oct. 10, the entire gathering of Institute members and friends boarded a special train, and the next morning found themselves on the Kansas-Missouri line, where a stop of an hour was made to inspect some steam-shovel operations in the southeast Kansas coal field. Here a gigantic 300-ton Marion shovel was stripping some twenty feet of overburden, six feet of which was a hard shale, to uncover thirty inches of coal. This coal was shovelled into small cars by hand, owing to the numerous "horses" or bands of rock intersecting the seam. About thirty men were idle in the pet during our stay, inasmuch as the mining company had no storage capacity in the tipple, and the railroad company was a little slow in getting in empty cars.

Proceeding, the party arrived at Webb City, Mo., where automobiles took them through the district, stopping first at the new mill of the Oronogo Circle Company, now nearly completed, and representing the latest and best development in this field. From here the automobiles proceeded through the "sheet-ground" district some five miles or more to the other end of the mineralized beds to Carterville, where luncheon was served at the American Davey Mines. Here an opportunity was given those interested to go underground, while others were toured through Joplin and Galena. Returning to Joplin an interesting session on Zinc was held, GEORGE C. STONE presiding. Later in the evening, the "Miners' Home," a reproduction of a frontier bar-room, was opened in the roof garden of the hotel, and all mining engineers found refreshment and excitement among the fire-eaters, cow-punchers, confidence men and gamblers who infested the place. Numerous prominent members were arrested by the sheriff, as they answered descriptions of sundry bandits, horse-thieves and common murderers, posted around the walls, while twice the occupants were "stuck-up" by desperadoes and relieved of all their "phoney" money. A delightful banquet completed the day's pleasures.

SESSION ON ZINC

"Oxide of Zinc" was the title of the paper read by the chairman, GEORGE C. STONE. This paper has been published in full in METALLURGICAL AND CHEMICAL ENGINEERING, Sept. 15, 1917, p. 308, and describes the production of the oxide from Franklinite or Wetherill grates. W. R. INGALLS then presented a short note on "Zinc Burning as a Metallurgical Process." He defined "zinc burning" as a process of igneous concentration wherein the zinc oxide in a furnace charge is reduced to metallic form, volatilized and then burned to zinc oxide, which oxide may be settled or filtered and used as such or as a raw material for further treatment. Mr. Ingalls noted that while zinc burning generally has been effected on Wetherill grates—merely a blast furnace process—it can also be done in blast furnaces (as at Florence, Col.), in reverberatories (as by Frederick Laist at Anaconda, Mont.), or in converters (experimentally by Babe, in Europe). Leaving aside the manufacture of pigment, which requires a product of excessive cleanness, zinc burning has many applications, as follows:

"1. As a simple means of concentrating low-grade ore, especially calamine, to save freight and treatment charges on worthless gangue. Thus, the calamine of Leadville might be taken to Canyon City, Col., the zinc might there be burned off and the zinc oxide shipped to distillers or to electrolytic refiners. This is in fact being done on a small scale.

"2. The residues from lixiviation in electrolytic zinc works, containing a large quantity of zinc owing to the formation of insoluble zinc ferrite in roasting, may be burned on Wetherill grates for the extraction of that zinc. This is going to be done. An ore containing 48 per cent of zinc and yielding 83 per cent of it to sulphuric acid may have a residue assaying 20 per cent zinc, the proportion of residue to original ore (roasted) being about one-third, and that 20 per cent of zinc is well worth extraction.

"3. It is possible that it may be found most economical in the electrolytic process to roast the ore, burn it

on Wetherill grates and subsequently leach the fume.

"4. The production of zinc fume in this way affords an excellent supply of zinc for the manufacture of lithopone and other chemical purposes."

The discussion brought out the further application of treating zinc-retort residues. These residues contain zinc values depending in quantity upon the excellence of roasting and richness of the original concentrate, sometimes running as high as 6 per cent. They also contain sufficient excess carbon to operate a Wetherill grate nicely, and at one plant in Oklahoma a considerable quantity of very excellent pigment is being made from such materials. In the treatment of zinc ores or residues in the blast furnace or reverberatory it is necessary, of course, to reduce the slag losses to as low a point as possible. The zinc is freed from the ore as a volatile metal, in a reducing reaction, and must be held as such until entirely free from the charge. Evidently a slag with oxides of low valency will therefore contain less zinc than otherwise. In this connection it was mentioned that the zinc remaining in a Wetherill clinker was smaller in quantity with a decreasing thickness of charge.

Mr. R. G. Hall, general manager of the River Smelting and Refining Co., operating an electrolytic zinc plant at Keokuk, Iowa, presented a paper entitled "Some Economic Factors in the Production of Electrolytic Zinc." He pointed out first, that "the electric power must be convenient to the ore supply, or as the ore moves toward the power it must also move toward the metal market. Northwestern power is favorably located with reference to its ore bodies, and Mississippi Valley power favorably located with reference to metal market. In neither case will transportation charges accrue to a too great or unredeemed extent." Mr. Hall thought that the retort method of treating rich and pure concentrates, such as the Joplin ores, has nothing to fear from electrolytic processes. The latter are chiefly desirable in the treatment of the complex intimate mixtures of zinc, lead, iron, copper and silver minerals so often encountered in the Rocky Mountains. The adaptability in this case is not alone the actual cost of reduction of the zinc itself, but also the relative values of the subsidiary metals recovered, as compared with the results of retort smelting. "The one requirement for successful electrolysis of zinc is zinc sulphate and zinc sulphate only." Contrary to general belief, the solution of iron is not difficult to circumvent, considerable copper, however, will be removed from its rightful place in the residue. The conditions which produce so-called insoluble zinc ferrite in the roasting process are fortunately not necessarily present in a leach-roast; such factors are high temperature, long time, and fineness of ore. The author briefly points out that interfering elements may be removed by putting a zinc fume into solution, the lead and silver content in this case being insoluble, compact and easily washed zinc-free. Self-fluxing complex ores can be charged in a blast furnace and the slag losses in zinc are only of the same order as the summation of losses in the various steps in the other processes.

In the discussion of Mr. Hall's paper, Lawrence Addicks mentioned the fact that while the high grade 60 per cent zinc concentrate produced in Joplin was material par excellence for the retort, still a 25 to 30 per cent concentrate might be made from the chats and tailings which would be very good material for an electrolytic zinc plant. Dr. J. W. Richards thought that since the retort smelting of zinc had improved perhaps 10 per cent in the last hundred years, while the electrolytic process had improved 100 per cent in the past five years, it was still too early to define the economic boundaries of the latter process. It seemed to him most important to determine how close to the end point the deposition can be carried, and how high the acidity of the solution can go. The chairman confirmed the author's statement that absolute purity in the electrolyte was the prime consideration.

In presenting his valuable paper on "Palmerton Zinc Refractories," Mr. C. P. Fiske said that the cost question in a pottery could be met in two ways, first by reducing the cost of the vessel, or second, by lengthening the service. The first method involves the reduction of labor charges, which has been effected to such an extent that seven men are enabled by the use of proper machinery to make 320 vessels per shift. He has tried to balance the cost of labor against the cost of operating additional automatic machinery, but was prepared to further reduce the men required if shortage of help demanded it. Involved in both methods of decreasing cost of vessels was the experimentation on retort-making materials, such as bond clay, calcined flint, and pulverized coke, the use of the latter, however, he regarded as of doubtful advantage. Pottery experiments, in general, are most difficult because they take a long time to complete, are liable to involve large losses, and the greatest care and supervision is essential. Therefore some method for determining quickly and surely the availability of any clay for a given duty is most desirable. In this connection Mr. Fiske regards the tensile test of air dried clay the most important and useful yet devised.

EXCURSION THROUGH THE MIAMI ZINC DISTRICT

Friday morning the travelers awoke in their berths and thought for a moment that they were aboard ship. The rolling and pitching of the cars was explained, however, by the fact that the rails over which we were proceeding had barely been laid, and that the roadbed was quite innocent of surfacing. Thus one is early introduced to the "newness" of the district. Mills and towns are springing up on every side, towns which jump at you out of a Bret Harte story book, towns where they have not yet had time to put in a culvert and fill a deep gulley crossing the main (and only) street. Breakfast was served in a large tent on top of Blue Mound, just over the line in Kansas, and from which an inclusive panorama of the district was obtained. After a few dances by some real American Indians, the party motored through the district, stopping at various mills and arriving at Miami for lunch, when the train left for Tulsa, where the large and orderly Cosden refinery was inspected during the late afternoon. The Tulsa committee entertained the visitors and guests at a very enjoyable banquet at Hotel Tulsa, following which a session on Petroleum was presided over by David White.

ORE-DRESSING PRACTICE

The ore-dressing practice in Joplin invites criticism from the visiting engineer. He is immediately struck with the multiplicity of small operating properties, and

reports of tailings dumps holding from 2 per cent zinc upwards. The local operator, however, maintains that his practice fits his conditions. That is to say, practically all mining is done by small operators under ten-year leases from the owner of the ground, who collects a royalty of from 10 to 20 per cent on the receipts from sales of concentrates. These leases ordinarily cover only forty acres of ground, often less, while the life of the mine is from six months to six years. The district as a whole seems to have had the benefit of little technical skill, and the whole object is to get out the rich dirt, make a clean, high-grade, coarse concentrate, and throw the rest away. Such small scale operation naturally militates against elaborate investigations or recoveries of fine concentrates or other refinements. The mills are uniformly built by millwrights, from the scantiest of plans, and of lumber and materials carried in stock or made locally. Consequently a new mill is ordinarily a copy of an older one, while innovations are short-lived owing to "the strong retrograde impulse which is so highly characteristic of the district."

All this explains conditions, but no reasons have yet been advanced why three mills operating within 100 yards of each other, each working one shift, could not consolidate their output and work one mill continuously. Or, taking a larger view, why a large block of ground could not be acquired, systematically developed and mined on a large scale, and more than 60 per cent of the zinc recovered. The newcomers evidently quickly acquire the local viewpoint, however. One operator was speaking of his seven-acre lease, and was asked why he did not acquire some of the adjoining area, and the reply was, "Oh, these seven acres will keep me busy for a while."

Mr. CLARENCE A. WRIGHT presented a discussion of the ore-dressing practice in Joplin which may here be abstracted. The average content of the ores mined is very low, the concentrate is very high grade, and the ratio of concentration is unusually high. The ore, or "dirt" as it is termed, is sometimes hand-picked, and broken to pass a 5-in. grizzly and then fed through a jaw crusher set at 2 in. The discharge is run directly to a set of rolls crushing to about ½ in., elevated, screened, and sent to the roughing jigs. The most common type of jig is known as the Cooley jig. It is of the fixed-sieve type; the number and size of the compartments depending upon the size and character of feed.

In general, a system of "roughing" and "cleaning" is followed in which the feed is given a preliminary cleaning that eliminates the greater proportion of waste material on one or two "rougher" jigs and the enriched product, which will assay anywhere from 10 to 25 per cent zinc, is cleaned on a "cleaner" jig for the final treatment, bringing the zinc tenor up to 50 to 60 per cent. The "chats" or included mineral particles from both the rougher and cleaner jigs, which together assay 4 to 8 per cent zinc, are recrushed and either returned to rougher-jig feed or treated separately in a "chat" jig. The tailings from the rougher jig are usually dewatered by means of a dewatering trommel having 1½-mm. to 2-mm. openings while they pass over the outside of the trommel as it slowly revolves. The undersize from this dewatering screen flows to the settling tanks and the oversize to the tailings elevator as waste. The overflow from the tailing end of the cleaner jig, and other jigs if used, also passes to the settling tanks.

During the past few years the use of tables has become general in the district, and nearly all mills contain from three to ten, the small number being due to the small tonnage of the mills and the minimum amount of fines produced. The feed, or "sludge," comes chiefly from the dewatering boxes at the end of the jigs, through a V-box with a continuous discharge and trommel. The usual practice makes clean lead and clean zinc concentrates; the intermediate material is returned to the feed, together with the middlings.

Flotation of the fines is in use at a few places. Tests by the Bureau of Mines showed that it is fairly easy to float the sphalerite by using warm solutions and about one pound per ton of any suitable wood or coal distillate, and that acidity separates the froth and tailing quickly. The present mill practice is however so firmly fixed that it will be difficult to convince operators of the desirability of adopting flotation extensively.

Mr. H. B. PULSIFER contrasted the operation of an old mill called the "Bohemian Girl," which was removed after three years' work, and the "Media" of about the same size jig-room but of three times the capacity (75 tons per hour). A flow-sheet of the Media is reproduced herewith. This mill has recovered about 2 per cent of the dirt as zinc, producing a 60 per cent zinc concentrate. The boiler plant and steam-engine drive has always been the main source of power in the district, and is unrivaled in low operating cost and reliability. The Media mill itself was constructed during the summer of 1915 at a cost of about $60,000, and paid for itself in four months' operation. It has continuously ground 1200 tons in 20 hours in its single jig room, the capacity being limited more by mining than mill speed. A large tailing pond was constructed at considerable expense, but the output was allowed to encroach so that the pond capacity vanished in a few months. The customary "dummy" elevator became

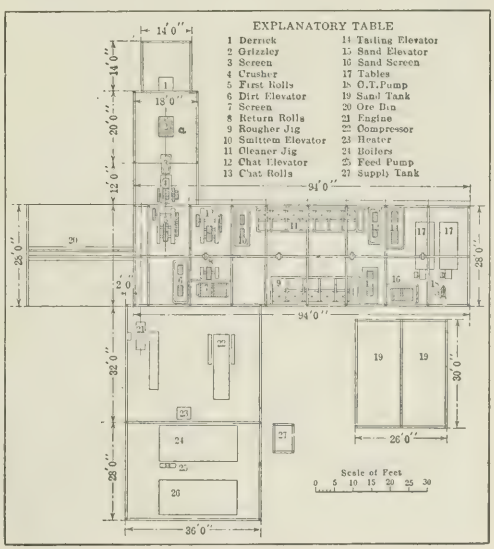


FIG. 1—FLOOR PLAN OF BOHEMIAN GIRL MILL

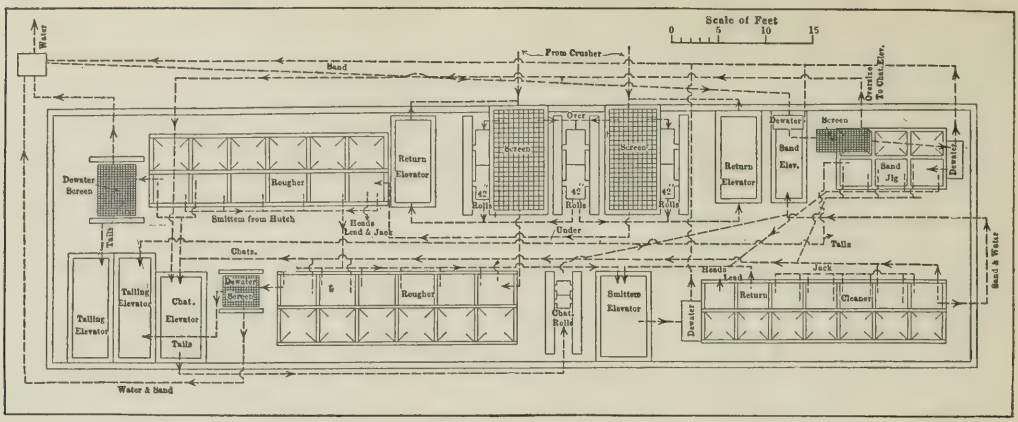


FIG. 2—FLOW SHEET OF MEDIA MILL

necessary. The greatest disadvantage is the undue crowding of shafting, belts, spouts and pipes in the jig room.

"The best features of the ore dressing may be enumerated:

"1. Main tonnage fall direct from hopper to tailing elevator; only oversize is re-elevated. Bad turns in main stream nearly absent.

"2. Splendid balance of unit capacity; no one unit crowded or choked while others are running light. If any capacity weakness develops it will probably be in the cleaner, chat-regrinding or sand units rather than in main tonnage units.

"3. The cleaner is of unusual size, only a few of this size ever having been built in the district.

"4. Ample facilities for dewatering sands and a sand jig in the main mill to treat cleaner sand and ground chats (settled rougher sand can also come back to this jig) relieves the roughers.

"5. The sand plant is entirely separate from the jig room, as is now fairly customary in the district. It has an equipment carefully selected and capable of excellent work.

"6. Mill water is elevated no higher than necessary; a second small pump supplies the high line to the crushers.

"7. The main tonnage flow is through twin units; this arrangement is happily combined with large units on the enriched segregate. Both streams being in the closest possible proximity, elevator fronts being open and nearly every unit being in full view, minimum attendance is required and instant response to mishap is possible."

OKLAHOMA ZINC SMELTERS

A large percentage of the Joplin-Miami "jack" is shipped into the Oklohoma gas fields, there being 78,672 retorts installed in fourteen different plants. The main impressions the casual visitor obtains from these plants is of their very flimsy buildings, their lack of labor-saving machinery, and the excessive heat losses through their furnace walls. Many of the plants are "war-brides," pure and simple, built to operate on high-price ore, and now in large measure cold. Quick and cheap construction was therefore the first consideration, the buildings being mostly of corrugated iron directly on wooden posts and girts. The furnaces themselves seem to be merely fire-brick screens to protect the buckstays. The usual straight line (Ropp) roaster is fired with a gas flame at every door. The smoke from these roasters is singularly free from visible dust, when working on ordinary concentrate. Flotation products are much more difficult to handle, both to dry and to roast. The size is of small advantage even in the retort, owing to the extreme difficulty of getting them thoroughly and uniformly mixed with the rest of the charge and properly moistened.

The retort furnaces themselves are set on the general yard level, a tunnel for residue cars being built directly underneath. Since cheap natural gas is used, no recuperators are constructed. There is little of novelty in the retort practice in this field—the rapid expansion of the furnace capacity has involved an acute shortage in furnacemen, and under these conditions few innovations are likely.

The furnace operator defends his practice by pointing out that substantial construction is impossible in a region depending upon a short-lived gas supply. This same gas supply, however, might be extended almost indefinitely by proper development and conservation. Again, mechanical handling of materials is not an economic possibility when such small quantities of materials are to be handled—perhaps 150 tons of concentrates daily at the average plant. It does seem, however, that locomotive cranes could supplant the laborer and his shovel in rehandling large quantities of stock-piled materials.

Globe-Miami Copper Strike Settled

The strike in the Globe-Miami copper district of Arizona is settled. The President's mediation commission has succeeded in working out a plan of adjustment which has been accepted by the managers of the Old Dominion, Miami, Inspiration, and the International Smelter, the controlling mines; President Moyer, of the International Union of Mine, Mill and Smelter Workers, and the local unions which are out on strike. This means the early resumption of copper production.

The Western Metallurgical Field

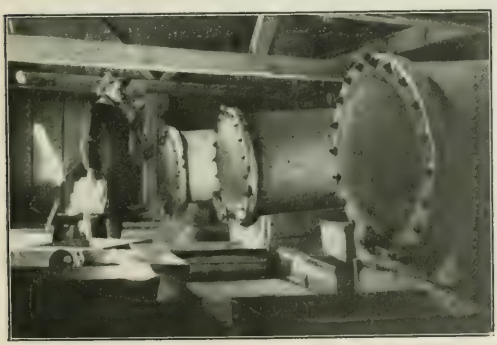
New Source of Sulphur in Colorado

A new source of sulphur is being made available to the Western market as a result of a bond and lease recently taken by Mr. Frank Bulkley of Denver, Col., on the property of the Colorado Sulphur Co., near Creede. The mineral deposit lies about 20 miles from Creede at the head of Sulphur Creek, a tributary of Trout Creek, which, in turn, flows into the Rio Grande. It was discovered by prospectors twenty or more years ago and was acquired in 1901 by the American Sulphur Co. A considerable sum of money was spent by this company before discovering that the deposit was on State school land, and therefore unpatentable. Litigation ensued as a result of an attempt by another party to secure a lease, but in 1906 the courts decided that the American Sulphur Co. was duly entitled to lease the land. A sub-lease was then granted to the Colorado Sulphur Co., which subsequently purchased the land from the State of Colorado.

Altogether about $100,000 has been spent on the development and equipment of the property. Considerable underground work has been done, including exploratory work by diamond drills. A small refinery was erected comprising three retorts having a capacity of from 5 to 10 tons refined sulphur per day, depending on the grade of the ore. As shown in the accompanying view, the retorts are simple cast-iron cylinders laid at a slight inclination, so that the molten sulphur may be tapped from the lower end.

An examination of the property reveals the existence of about 30,000 tons of ore within a certain area, which will average 50 per cent sulphur. Samples of 100 lb. each taken in the usual approved manner from fourteen exposures of ore gave assays ranging from 41 per cent to 65 per cent sulphur, with an arithmetical average of 57.7 per cent.

The refining process is simple. Ore is loaded into small perforated-bottom cars which have been previously lined with burlap. These cars are then run into the retorts, and after the heads are bolted on, steam is turned in. The sulphur melts and runs through the burlap, while the unmelted gangue remains in the cars. Liquation thus proceeds for about an hour, after which the steam is turned off, the cars taken out and discharged. The melted sulphur is run out into pans and cooled, after which it is crushed and ground as required for market. The product is practically pure sulphur, analyzing over 99.5 per cent pure in carload lots. No arsenic, selenium, tellurium or other deleterious elements are present.



RETORT AND SULPHUR PANS

Operations are now proceeding in a small way until next spring, when the refinery will be enlarged and motor trucks will be used for transportation of the product.

Zinc Production in Missouri

At the present time $75 "ore" means curtailment in Joplin production. The casual observer might express surprise that the present price of zinc—somewhat over 8 cents—would not bring out the maximum quantity of that metal. The cost of labor, but more especially of supplies, has increased so largely that the total cost of mining and milling in the larger, more economical mines has increased from $1.05 in 1914 to $1.32 in 1916, and possibly $1.50 to-day. Present costs in the Miami (Oklahoma) district are close to $2 per ton.

In order to translate these mining costs into a figure which may be comparable with the price the miners are receiving for their "ore" or concentrates, one must recollect the excessively large concentration ratio ruling in Joplin. This ratio is becoming smaller all the time; thus 3.14 tons of concentrate were produced from 100 tons of "dirt" in 1914; 2.70 in 1915, 2.56 in 1916, and possibly 2.45 now. Dividing the cost of mining and milling 100 tons of "dirt" by these respective figures, it will be apparent how the cost per ton of concentrates has jumped from $34 in 1914 to $61 to-day. Now if a royalty of from 10 to 15 per cent be added to these figures, even the more modern producers of low-grade dirt will have a hard time to continue on a $75 basis, while many of the smaller operators have already succumbed. While the Miami district costs are higher, the zinc content of the veins is also much better, so that concentrates can easily be produced at that place for $50 a ton. Under such circumstances the exodus of operators from Joplin, Webb City and Carterville into the boom towns about Picher, and the dismantlement of many mills for re-erection in Oklahoma, is not surprising.

Many hundreds of retorts in Oklahoma are cold. If a ton of concentrates will produce 1000 lb. of spelter, at say 8¼ cents, the smelters will receive $82.50 for their metal. Transportation and selling of ore and metal costs in the neighborhood of $5 per ton, while smelting costs are perhaps $15. Subtracting $20 from the price of the metal means that a smelting company cannot make a great deal of money at the present price of concentrates—in fact, many have given up the attempt.

The slump in spelter is doubtless due to the high price of galvanized products. This industry normally absorbs well over half the entire production of zinc. What with the extraordinary price of zinc early in the war, and the more extraordinary price of the iron sheets and wire forming the base of galvanized articles, the price of this class of goods has been put so high that the ultimate consumer either does without or takes a substitute—purchases galvanized fencing and corrugated sheets only as a last resort, perhaps after he has sold some of his potatoes or wheat. The effect of a stagnating market for galvanized ware on "war-bride" zinc retort capacity (doubled since the war) is very apparent.

American Iron and Steel Institute

The thirteenth general meeting of the American Iron and Steel Institute, held in Cincinnati, October 26-27, 1917, at the Hotel Sinton, was marked by the remarkable spirit of all the members for co-operation with the government, which was brought to a fitting climax when, at the request of Judge Gary, all present rose and pledged themselves to do their utmost for the service of their country.

On Friday, the morning and afternoon sessions were given up to the reading and discussion of the papers, and in the evening a banquet was held at the hotel, after which informal speeches were made by Mr. Charles P. Taft, Mr. George Verity, Captain R. W. Hunt, Mr. C. W. Howard, Mr. C. M. Schwab, Mr. J. A. Farrell and others, all of them dealing with the relation of the steel industry to the war.

Saturday was given over to visits to the various points of interest around Cincinnati.

The morning session on Friday was opened with the Presidential Address by Judge GARY, a remarkable speech in many ways, in which he brought out with great force the enormous burden which the iron and steel industry is called upon to bear.

After this speech Judge Gary called upon several members of the audience for informal discussion.

Colonel LAMBERT said that after hearing the speech there was not much to say except that we indorse every word of it, and that we will do our full duty.

Mr. HOWARD of St. Louis said that we should take the message to heart deeply, and remember all service possible, showing the way to the world.

Mr. FARRELL, president of the United States Steel Corporation, stated that the war had brought changes in all industry, particularly the iron and steel industry. He said that it was an economic war, and that we must not only send men to the front, but we must also produce the necessary materials, etc. He also said that we all must co-operate, as in the end the winning of the war would depend on the United States, and particularly on the iron and steel industry.

Mr. SCHWAB, president of the Bethlehem Steel Company, said that he welcomed the opportunity to praise the president's address. In his own plant he was employing 80,000 men and had $600,000,000 worth of contracts on the books, of which he was glad to say over 90 per cent were for the government. He called the institute's attention to the remarkable ability and diplomacy with which Judge Gary had conducted his dealings with the Council of National Defense at Washington, always considering the best interest of the country and the steel industry as a whole, at many times to the disadvantage of the corporation. A report of the technical papers will be given in our next issue.

Helping to Win the War by Stimulating Liberty Bond Sales

Liberty Loan meeting of employees of McGraw-Hill Publishing Company, Inc., at which there was unfurled a service flag with 42 stars, showing that 42 members of the company have entered military service. Since the meeting 4 stars have been added

How Do the Warring Nations Obtain Their Nitrogen Supply?*

By S. Nauchkoff

The great chemist Liebig once uttered the words "without phosphorus, no mind," and this expression, in a somewhat altered form, can truly be applied to an element closely related to phosphorus, namely nitrogen, in that we can say "without nitrogen, no war." To such an extent was and is war dependent upon this, in itself, so simple and common non-metal, that we would almost wish that in an instant it could be excluded from the list of the chemical elements. But as long as the human brain has access to phosphorus it may well be assumed that substitutes for nitrogen would quickly be invented and put at the disposal of the militarists.

A discussion of the nitrogen question and its importance from the military point of view, which at the present time is of considerable interest, can be found in Ostwald's "Abrandlungen and Vorträge," written during the summer of 1903. Ostwald says there: "If today a war should break out between two great powers, of which one were in a position to prevent the export of saltpeter from the few ports of Chile, it would thereby make it impossible for the enemy to continue the war longer than its ammunition supply should last. At present this condition is not very serious for Germany, as on account of the requirements for agriculture and chemical industries the stock of saltpeter in the country is so large that even the considerable military requirements could be met. This, of course, holds true only until the deposits in Chile approach their exhaustion."

Whether Ostwald when he wrote this had the relation between Germany and England in mind does not appear from his argument, but it does not seem to be unlikely. To draw a conclusion from the statistics as to Germany's saltpeter stock at the beginning of the war is not possible, although Washburn[1] estimates it at approximately 660 thousand tons. This, therefore, corresponded to what Ostwald termed "the considerable military requirements," and was certainly very much greater than the stock of England. Furthermore,

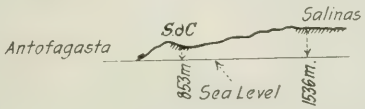


FIG. 2.

the Germans by the capture of Antwerp are said to have obtained about 200,000 tons of saltpeter. One can, therefore readily understand that the Germans at the beginning of the war, regardless of their inferiority at sea, risked the attempt to blockade the Chilean ports with their cruisers; and it may not be considered impossible that a future operating field for the German submarines will be the coast of Chile.

The Chilean saltpeter industry is in many respects very interesting and a short résumé of the same will, therefore, first be given.

As seen from Fig. 1, the most important saltpeter deposits are located in a belt parallel with the coast, reaching from 19½ to 24½ south latitude and entirely within the rainless and desert regions of the coast The elevation above sea level of part of the saltpeter fields is considerable, reaching 1550 meters, as seen

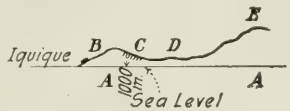


FIG. 3.

from Figs. 2 and 3, showing the Antofogasta district in the south and the Iquique district in the north. The nitrate-bearing earth or "caliche" which is found a few feet below the surface has a thickness varying from a few inches up to 12 feet, the average being approximately two feet. The caliche rests on a bottom which consists of a soft earth, known as the "coba" and is covered by a compact over-burden of earth, known as the "costra." The saltpeter content varies considerably, for example, from 25-40 per cent in the Atacama district and 30-50 per cent in the Tarapaca district.

Concerning the formation of the saltpeter deposits the opinion among geologists differ. The theory of Nöller seems, however, to be the most likely. He declares that their origin is due to the collection of enormous quantities of sea-weed, which together with the salt from the sea water formed the nitrate during their decomposition. A proof of this is the large iodine content of Chile saltpeter.

In this connection it may be sufficient to refer to Figs. 4, 5, 7 and 8, showing how the saltpeter is recovered from the caliche.

To give an idea of how inefficient the saltpeter ex-

*Paper presented before the Swedish Technological Society, Section of Chemistry and Mining, Feb. 8, 1917.—Translated from *Teknisk Tidskrift* for February-March, 1917.

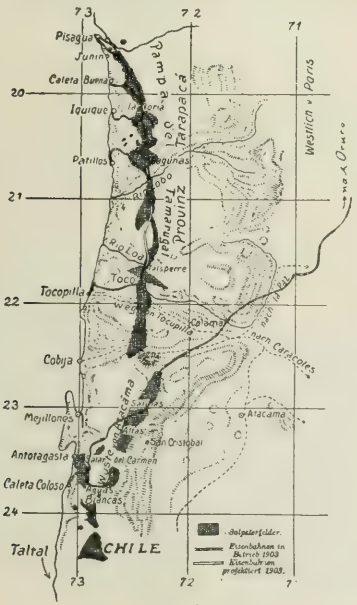


FIG. 1.

[1]Met. & Chem. Eng., Apr. 15, 1916, p. 419.

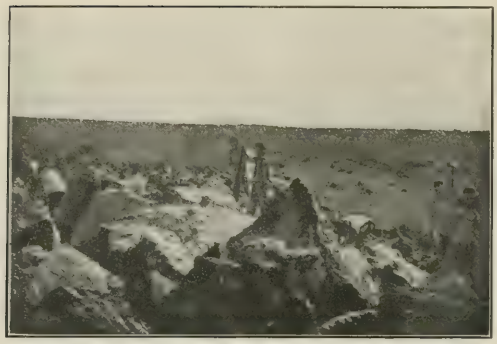


FIG. 4. MINING OF CALICHE AFTER BLASTING THE COSTRA.

traction is in the Chilean factories, it may be mentioned that when working a 35 per cent caliche, the following losses, which for a European chemist appear amazingly large, are figured:

	Per cent.
In transport from the saltpeter fields to the refining works (Oficinas)	7.0
In crushing and solution of the caliche	2.0
In the residue (Ripio)	14.3
In drying and in end solutions	8.7
Total	32.0

The finished product, the fertilizer saltpeter, has a $NaNO_3$ content of about 95-96 per cent, corresponding to about 15 per cent N, and contains ordinarily from 1-1.5 per cent NaCl besides smaller amounts of sulphates, perchlorates, iodines, etc.

The moisture content generally is between 2 and 3 per cent.

Besides the above, there is in the market a "refined" saltpeter with a standard content of 96-97 per cent $NaNO_3$ and less than 1 per cent NaCl. This is mainly used for the manufacture of nitric acid and for other chemical purposes.

Coming then to the question of the saltpeter trade, I will first endeavor to illustrate by diagram, Fig. 6 showing Chile's saltpeter production for 1870-1916, how the same has expanded during the last 35 years. The scale to the left in the diagram gives the quantity of saltpeter in thousand tons, and the scale to the right the corresponding amount of nitrogen, also in thousands of tons.

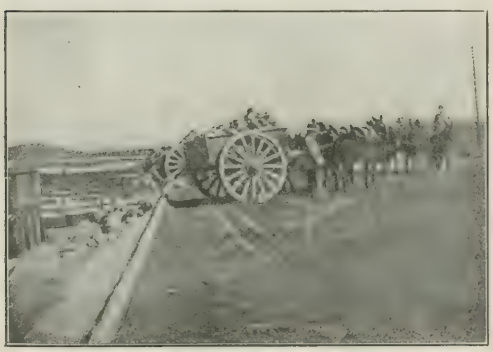


FIG. 5. DUMPING THE CALICHE INTO THE SILOS ABOVE THE CRUSHERS.

As it is at once apparent what an enormous increase in production has taken place during this comparatively short period, the question naturally arises: "How long can the Chile saltpeter deposits last?"

To find an even approximately correct answer to this is, however, impossible. It appears almost that it is with the Chilean saltpeter deposits as with the Swedish iron ore deposits; they grow with every new estimate and investigation.

While about 1860 the available deposit of saltpeter was estimated to be 63 million tons, this figure was twenty years later increased to 178 million tons. In 1888 the Chilean saltpeter officials, however, declared that the deposits would last only for 25 years longer, i.e., would be exhausted by 1913, although in 1900 they declared that the time limit could then be extended to 1940. In 1907 it was found that the deposits would last to the year 2032, and finally the Chilean Government announced in 1909 that at least 340 million tons could yet be economically mined, which, at a yearly production of 2.5 million tons, would correspond to a period of 136 years. In Europe, however, no faith is had in these Chilean reports, and it is generally believed that these high estimates have been made only to enable Chile to maintain its credit in the European and American money markets. That the saltpeter industry is of the greatest importance to the Chile Government is readily understood from the fact that the export duty of saltpeter, which is not less than 28 pence per Spanish cwt. (46 kg.), corresponding to around 25 per cent of the saltpeter value in a Chilean port, covers approximately 40 per cent of the Government's total expenses.

European authorities figure now that the Chilean deposits will last not more than 50 to 60 years, and this is also the reason why preparations are beginning to be

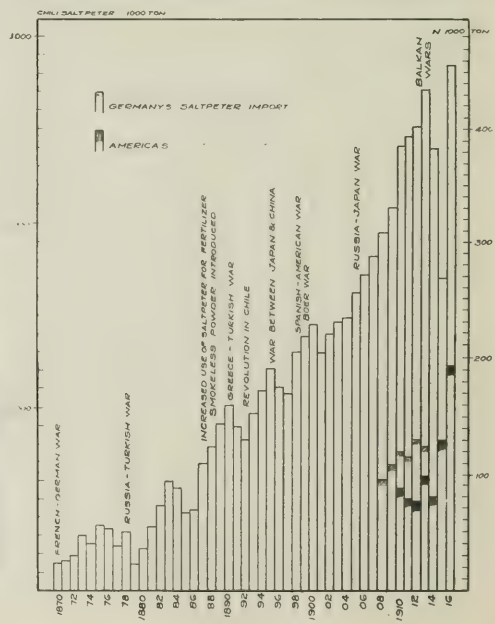


FIG. 6.

made in Europe to make it independent of the Chile saltpeter.

A closer study of the diagram shows, furthermore, several other interesting facts, but in this connection we are mainly interested in the effect of the war on the saltpeter consumption. Nearly every war is marked by a distinct increase in the production, but compared with the present conditions the nitrogen consumption of the wars of the past 30 years have been mere trifles to this war's enormous requirements. The incomparably greatest increase in saltpeter consumption during the past 25 years refers, however, to the increase in its use for fertilizer purposes.

By studying the saltpeter production in the diagram for the past 4 years, it is at once apparent what violent fluctuations the present war has caused in the saltpeter trade. At the beginning of the war the saltpeter export to Europe stopped almost entirely, and work was discontinued in more than two-thirds of the approximately 135 refineries which were in operation at that time. At the same time the saltpeter stock in Chile increased from about 500,000 tons in January, 1914, to about 1,100,000 tons in January, 1915. During the first half of the year 1915 the production dropped further, when, due to the increased ammunition production in America, it began to rise rapidly until during 1916 it reached the record figure of 2,878,000 tons. At that time 116 refineries were working at full capacity. Of the above, not less than 1,200,000 tons was taken by America against about 500,000 tons before the war.

The diagram further shows Germany's saltpeter import during 1908-1911, according to official German statistics and also America's import during the past 7 years. From this it follows that Germany's total normal requirements of saltpeter for agricultural and industrial purposes have amounted to about 800,000 tons, corresponding to about 120,000 tons of nitrogen.

At the same time I can mention that the German ammonium sulphate production during 1913 amounted to 550,000 tons, corresponding to 110,000 tons nitrogen, this, however, not including the ammonium sulphate produced by the Haber process. Germany's total nitrogen requirements during 1913 may, therefore, have been about 228,000 tons. Of this, according to Kochmann (Deutscher Salpeter 1913), 146,000 tons of nitrogen was used for fertilizer purposes. The balance, 82,000 tons, can, therefore, be assumed to have been used in the German chemical industry, mainly for dyes and explosives.

Before leaving the Chile saltpeter I will endeavor to show with a few figures how the prices for the same are made up.

At a normal price of about 185 marks (or shillings) per ton, f. o. b. a port in the North Sea, approximately 55 mks. (s.) can be figured as the cost of production, about 50 mks. (s.) as export duty, and about 17.5 mks. (s.) for transportation. The balance, 62.5 mks. (s.), therefore, covers the commercial expenses and the profit.

At present when saltpeter is quoted at £20 in Liverpool, about 70 to 80s. goes to cost of production, 50s. to export duty and 150 to 160s. to freight. The balance, 110 to 130s., covers commercial expenses and profit.

AMMONIUM SULPHATE

A comparison between diagrams Fig. 9 and Fig. 10 illustrates plainly that, of the natural nitrogen sources, Chile saltpeter has without question been of the greatest significance. How the importance of the ammonium sulphate constantly increases appears from the diagram in Fig. 10, which shows the production of ammonium sulphate in England and Germany during the past 25 years. England, which earlier controlled the ammonium sulphate market, had in 1910 to concede this place to Germany. Germany and England each produced at that time somewhat more than one-third of the entire world production. During the last four years England's production of ammonium sulphate has been nearly constant at a little over 400,000 tons (or 82,000 tons nitrogen) while the production in Germany has increased rapidly. Figures for the years since the war broke out are, however, not available, but with a knowledge of the enormous increase in the coke-oven industry in Germany, which is said to have more than doubled, we may not be far from correct if we estimate the production in this manner to approximately 150 to 200 thousand tons of nitrogen. In America, also, the coke-oven industry has expanded considerably and the recovery of by-products has at the same time reached constantly greater proportions, this quite naturally in order to obtain raw materials for the enormously increased manufacture of ammunition. According to the *Chemical Trade Journal*, the ammonium sulphate production in America amounted in 1916 to 325,000 tons, an increase over 1915 of not less than 105,000 tons. If we

FIG. 7. SALTPETER FACTORY, OFICINAS, AT SAN JOSÉ, IN THE TARAPACA DISTRICT.

FIG. 8. SALTPETER BEING LOADED FROM THE CRYSTALLIZATION TANKS INTO CARS TO BE CONVEYED TO STORAGE.

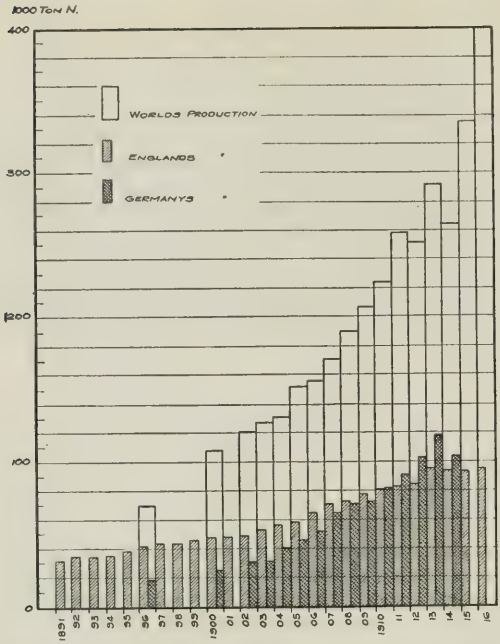


FIG. 9. GRAPHIC REPRESENTATION OF THE PRODUCTION OF AMMONIUM SULPHATE DURING THE 25-YEAR PERIOD 1891-1916.

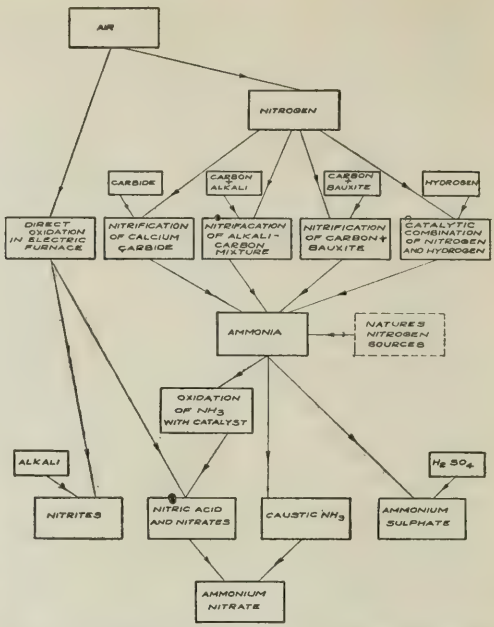


FIG. 10. RELATION BETWEEN THE DIFFERENT METHODS OF ATMOSPHERIC NITROGEN FIXATION.

further consider that a considerable increase is likely to have taken place in other countries, it may be safe to estimate the world's production of ammonium sulphate during 1916 at more than 1.6 million tons or more than 330 thousand tons of nitrogen. This proves that ammonium sulphate, as a source of nitrogen, has reached nearly the same importance as Chile saltpeter. With a closer comparison, however, one must consider that when fertilizers are concerned, the fertilizing value of ammonium nitrogen can be valued only at about 70-80 per cent of that of saltpeter nitrogen.

The above natural nitrogen sources, saltpeter and ammonium sulphate from coal have, however, been far from sufficient to fill the enormously increased demand, caused by the world war. Artificial nitrogen products also have come into use to a very great extent, and in this case the atmosphere has been relied upon to furnish the raw material.

ATMOSPHERIC NITROGEN

Fig. 10 is intended to represent the different methods for fixation of atmospheric nitrogen and their relation to each other. In general, these processes may be divided into two groups. First, those for producing saltpeter-nitrogen and, second, the processes for producing ammonia-nitrogen. The former methods are based on the combustion of the nitrogen in the air, at high temperatures, at the expense of the oxygen therein, and the nitric oxide which is obtained as a first product can then readily be converted to nitric acid and nitrates. The latter methods include both those according to which synthetic ammonia is produced directly from the nitrogen in the air and from free hydrogen, and those which necessitate a round-about way by means of other nitrogen combinations such as cyanamid, cyanides, nitrides, etc. The latter processes generally presuppose that the nitrogen in the air is separated from the oxygen, which nowadays is most readily done by liquefaction and fractionation of the air.

As the largest part of the nitrogen for ammunition manufacture is used in the form of nitric acid, it follows that the ammonia which is produced according to any of the above mentioned methods, or as a by-product in coke manufacture, must be converted into nitric acid, which is possible by the catalytic oxidation process.

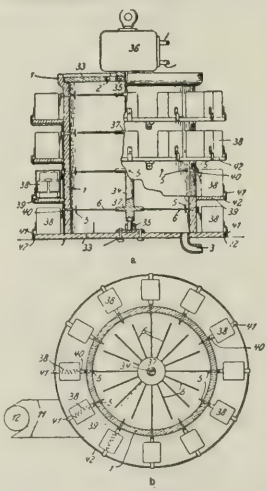


FIG. 11. BRADLEY AND LOVEJOY'S APPARATUS FOR ATMOSPHERIC NITROGEN PRODUCTION

COMBUSTION OF AIR BY ELECTRICITY

As everyone remembers, it attracted a good deal of attention, when in the beginning of this century it was announced that a process had been invented in America whereby it was possible to produce nitric acid from atmospheric air. Bradley and Lovejoy built a small factory at

Niagara Falls where extensive and very expensive experiments were conducted with an apparatus which they had designed. Their aim was to oxidize the nitrogen of the air by leading it through a large number of small electric arcs, formed between movable electrodes in the interior of the apparatus, Fig. 11. After years of trials and great expense the experiments had to be given up and it was with these results fresh in mind that many, a few years later, received the announcement of the Birkeland-Eyde experiments with considerable doubt. This process has, nevertheless, been the entering wedge in this field and the origin of a gigantic industry favored by our northern conditions.

As is well known, the combustion of the nitrogen in this furnace takes place in an electric arc formed between two copper electrodes, which by the action of a strong magnetic field is expanded to a circular disk of large dimensions, often over 2 meters in diameter, Fig.

FIG. 12. THE ARC IN A BIRKELAND-EYDE FURNACE

12. The arc is produced by means of a high tension alternating current having a frequency of around 50 cycles. The larger furnaces, in which the arc has a diameter of about 2.5 meters, utilize up to 3500 kilowatts. An air current of approximately 2 cubic meters per minute is forced through the furnace, whereby the outgoing gas has an NO content of about 1.5 per cent. The gas leaves the furnaces with a temperature of 800-1000 deg. C., and is led through specially designed boilers, where it gives off the greater part of its heat and the temperature is reduced to 150-200 deg. The gases thereafter pass through aluminium coolers which further lower the temperature to a value which is suitable for the subsequent oxidation process. This oxidation of the nitric oxid with oxygen from the air takes place in large chambers of iron covered on the inside by acid-proof material. From these oxidation chambers the gases are led to a system of absorption towers, built of acid-proof granite, Fig. 15. A spray of water is sent through the last of these towers in the opposite direction to the entering gas and the weak acid, which is obtained here, is then successively led to the other towers, also in a direction opposite to the flow of the gas. The first tower gives in this way a nitric acid of up to 50 per cent concentration. For the final absorption, the gases which are

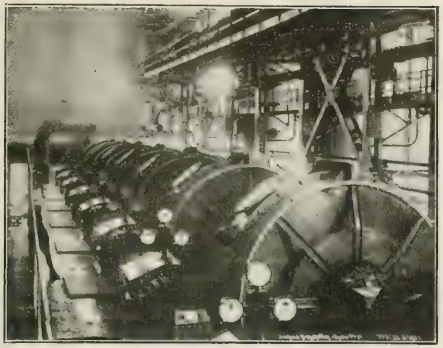


FIG. 13. BIRKELAND-EYDE FURNACE IN THE FACTORY AT RJUKAN IN NORWAY. CAPACITY OF EACH UNIT 3500 KW.

not absorbed in the water are led through an iron tower containing a soda solution, from which a solution of nitrate and nitrite is obtained. In this way up to 96 per cent of the oxidized nitrogen is recovered. From the nitrate-nitrite solution nitrate can be produced or, also, by letting the solution go to the first tower together with the strong nitric acid, the nitrite is decomposed and a nitrate solution obtained from which sodium nitrate of great purity can be produced.

With a 96 per cent NO absorption the Birkeland-Eyde process gives 550 kg. nitric acid per kilowatt-year of energy utilized in the furnace itself. A furnace of a capacity, as previously given (3500 kw.), produces therefore with continuous operation 1925 tons of nitric acid, corresponding to 420 tons of fixed nitrogen per year. Of this about 85 per cent is in the form of a nitric acid with a 40-50 per cent concentration and the balance, about 15 per cent, in the form of sodium nitrate. The operation of blowers, pumps and other auxiliary machinery require an additional energy consumption of about 7 per cent of the energy utilized in the furnace. Other losses (shut-down as well as concentration losses when an acid of high concentration is produced) can also be figured at 7 per cent, and the final result can therefore be taken as 425 kg. 96 per cent nitric acid = 91 kg. nitrogen, and 102 kg. 96 per cent sodium nitrate = 16 kg. nitrogen; total per kw. year, 107 kg. nitrogen, or approximately 80 kg. nitrogen per hp. year.

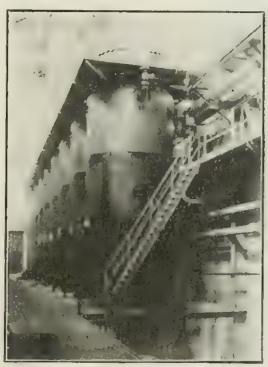


FIG. 14. STEAM BOILERS IN THE RJUKAN FACTORY, HEATED WITH THE GASES FROM THE ELECTRIC ARC FURNACES.

About the time when the Birkeland-Eyde process began to get a practical application in the factories at Notodden in Norway, the Badische Anilin und Sodafabrik finished experimenting with a furnace design invented by Schönherr and based on a long drawn electric arc. This invention was acquired by the Norwegian Nitrogen Company, in which the Badische

Company had large financial interests, and part of the first large installation at Rjukan was built according to this system. The Schönherr furnace has the form of a long vertical tube, at both ends of which electrodes are applied. The arc has a length of from 5 to 7 meters. The air which is blown in tangentially at the lower end of the tube passes with a whirling movement around the arc and leaves the furnace at the upper end, where special cooling devices are provided to rapidly cool the gases. The Schönherr furnaces are built for much smaller capacities than the Birkeland-Eyde type. They utilize generally only from 500 to 1000 kilowatts, and the manufacture of a certain quantity of nitrogen compounds will, therefore, require four times as many furnace units of the latter type. With the Schönherr furnace a somewhat higher gas concentration can be reached than with the Birkeland-Eyde furnace, but the nitric acid exchange, figured per kilowatt year, remains practically the same.

Several other arc furnaces have been designed. Of these, however, only those of Pauling, v. Kock, and Moscicki have come to any practical use. The two former seem to be used to quite a considerable extent in Germany during the war, and one factory is working in Schweitz which utilizes the Moscicki method. Pauling and v. Kock furnaces are based on the horn-gap lightning arrester principle, i. e., the arc is formed between two electrodes similar to horn-gaps. Air is blown into the gap where the distance between the electrodes is smallest, the arc travelling upwards as the nitric oxide is formed. Moscicki produces an arc between two copper pipe electrodes, concentrically arranged. By putting this arc under the influence of a strong magnetic field, in which the lines of force pass at right angles to the electric discharge, he causes the arc to travel around. With a sufficiently high rotation the arc obtains the form of a circular disc and air is blown through this at a certain regulated rate.

THE EXPLOSION-COMBUSTION METHOD

A few words may also be said about a method closely related to the electric-air combustion or arc method, which, however, has not as yet come to any practical use, but which offers various points of interest. This refers to the Hausser explosion-combustion process, which is based on the principle that in an explosion of a gas mixture containing air, part of the nitrogen of the air is oxidized. In a large experimental factory in Germany the method was carried out as follows: In explosion bombs, having a volume of from 200 to 300 liters, a mixture of coke-oven gas, air and oxygen was compressed to a pressure of from 4 to 5 atmospheres, after which the mixture was exploded by an electric spark. The bombs are provided with regulating valves, which are manipulated so that the filling, exploding and blowing-out of the explosion gases can be repeated 50 to 60 times per minute. The gases have a NO content of 0.7-0.8 per cent and are consequently much weaker than the gas obtained in the electric arc furnaces. According to Dobbelstein, about 190 gr. of HNO_3 was obtained for each cubic meter of gas of 4300 heat units. Based on a nitrogen price of 1300 mk. per ton in the form of lime nitrogen, Dobbelstein figures that 2.4 pf. per cubic meter can be paid for the gas, while, if concentrated nitric acid with a nitrogen value of 1830 mk. per ton is manufactured, the gas can be paid for at 3.3 pf. per cubic meter; that is, it would be worth four times as much as if it was used for boiler fuel. It may not, therefore, be entirely impossible that the process can be developed as a paying industry in connection with the distillation of coal.

To work with the lean gases yielded by this process, offers, however, naturally many difficulties, and in Germany at present it appears to be preferable to use the coke-oven gases for motor drive for generating electric power for production of cyanamid or for the arc process.

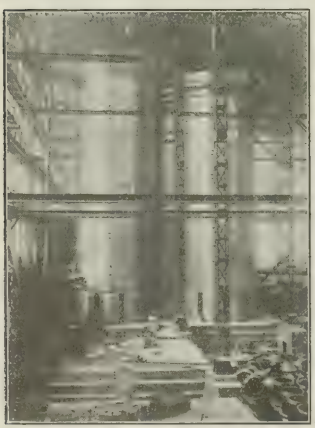


FIG. 15. ABSORPTION TOWERS OF ACID-PRO F GRANITE IN THE RJUKAN FACTORIES.

TRANSFORMATION OF NITROGEN INTO AMMONIA

Several methods have been invented for fixing the nitrogen in the air in such a manner that it can readily be converted into ammonia-nitrogen. Neglecting the attempts which were made during the middle of last century to fix the nitrogen in the air in the form of cyanides, a method which, however, is again being given consideration as a possible solution of the nitrogen-fixation problem, it can be said that the cyanamid process by Frank and Caro has been the pioneer in the field. This method, which was originally worked for producing cyanide for gold extraction, soon changed its aspect. Without aiming at it, Frank and Caro had found a method, the main feature of which was its possibility of transforming the nitrogen in the air to ammonia. The method therefore became of the greatest importance for the fertilizer industry and this regardless of the fact that cyanamid in itself has not proved equal to the expectations of those who thought they saw in it an excellent fertilizing material.

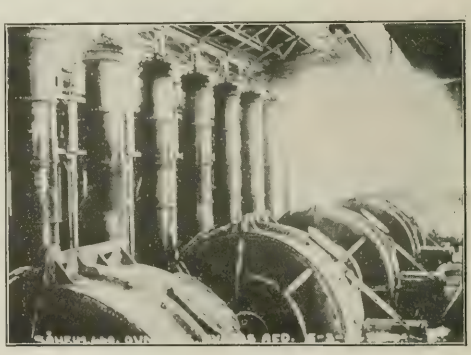


FIG. 16. SCHÖNHERR FURNACES IN THE RJUKAN FACTORY.

THE CYANAMID PROCESS

As is well known the Frank and Caro process is based on the property of carbide whereby it will absorb nitrogen at a high temperature, forming cyanamid according to the equation

$$CaC_2 + N_2 = CaCN_2 + C$$

This reaction takes place at such a high temperature, about 1000 deg. C. that great difficulties were encountered to begin with. By use of an activating agent, such as potassium chloride proposed by Polzenius or calcium fluoride by Carlsson, it has, however, been possible to reduce the nitrification temperature to 700-800 deg. C. The nitrification itself is done in furnaces of widely differing construction, both of the continuous and the intermittent type, with direct or electric heating. The nitrogen needed is produced either by leading air over incandescent copper or, as is now most common, by fractionation of liquid air according to the Linde or Claude processes.

Compared with the previously mentioned arc processes, the cyanamid process for nitrogen-fixation requires considerably less energy. Not less than 2 tons of 20 per cent lime-nitrogen can thus be produced per kilowatt-year, corresponding to 420 kg. nitrogen or approximately four times as much as with the Birkeland-Eyde method.

THE NITRIDE PROCESS

A clever method for fixation of the nitrogen in the air is the Serpek process for the production of aluminium nitride. Serpek discovered that if pure nitrogen was permitted to act on aluminium ores or bauxite and carbon, at a temperature of from 1500-2000 deg. C., aluminium nitride, AlN, was formed, which can readily be transformed into ammonia and alumina. Rotating electric furnaces as shown in Fig. 17 are used for the process. The method therefore serves the double purpose of nitrogen-fixation and alumina recovery and it is on this assumption that its economical possibilities are based. Up to the present it has, however, not been possible to make the process a financial success, undoubtedly on account of the technical difficulties in connection with the high working temperatures which have yet to be overcome.

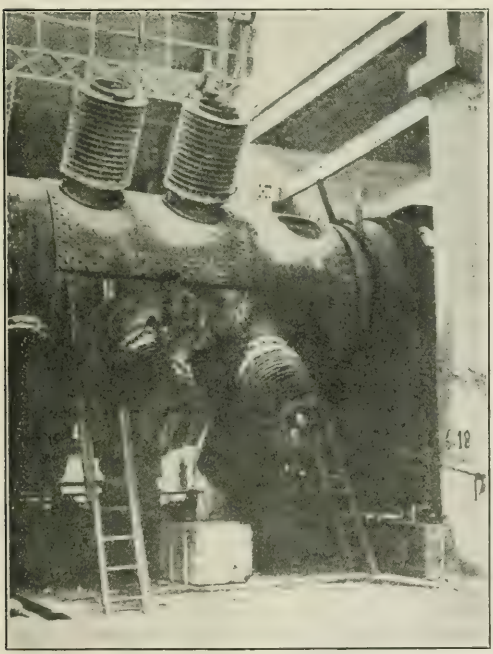


FIG. 17. SERPEK FURNACE FOR THE PRODUCTION OF ALUMINIUM NITRIDE. THE ILLUSTRATION SHOWS THAT PART OF THE FURNACE WHERE THE ELECTRODES ARE APPLIED.

As to energy consumption, the Serpek process is superior to the previously described processes in that from 500 to 600 kg. nitrogen can be fixed per kilowatt-year and at the same time 2 tons of alumina be obtained. As mentioned, the difficulties of the process have as yet not been overcome, and it seems that the factories which were built in France and Norway have had to discontinue their operation.

Closely related to the previous methods for atmospheric-nitrogen fixation is one invented in Sweden by Lindblad and Yngström. Like the Serpek process it is a combination process and is based on the fact that an alkali ore mixed with coal and melted in an electric furnace possesses the ability to absorb nitrogen with the formation of cyanides. From the cyanide thus obtained, ammonia and potash are then produced. The nitrogen production according to this method is claimed to be about 100 kg. per kilowatt-year, consequently quite low, although the importance of the process lies in the fact that the alkali is simultaneously obtained.

THE SYNTHETIC AMMONIA PROCESS

We will now leave the indirect methods for converting the nitrogen into ammonia and proceed to the direct one, the Haber synthetic process, in which the technical development excels at present. The idea of uniting nitrogen and hydrogen under high temperatures and pressures in the presence of a catalyst is not new, as is among other things apparent from the following statement in Graham-Ottos's text book, published in 1881; "If hydrogen and nitrogen are mixed in the proportions in which they are contained in ammonia, no combination can be produced by means of pressure, heating or platinum catalyst." Several inventors have, however, since that time been able to prove that light electric discharges, or the action of catalysts, even so simple as the common metals, have produced ammonia in not inconsiderable quantities. In 1907 Nernst and Jost carried out a series of extensive experiments to determine the equilibrium in the system

$$3H_2 + N_2 \leftrightarrows 2NH_3$$

and obtained thereby a confirmation of what they had previously predicted on the basis of theoretical conclusions; that is, that a higher pressure results in a quicker reaction and a higher ammonia concentration. With manganese as a catalyst, a temperature of 700 deg. C. and a pressure of 50 atmospheres, Nernst succeeded in reaching a concentration 0.9 volume per cent, but he still was very doubtful as to the ultimate success of any direct synthetic ammonia process. In this respect, the problem was therefore not new when Harber, with the assistance of Le Rossignol in 1907-1908

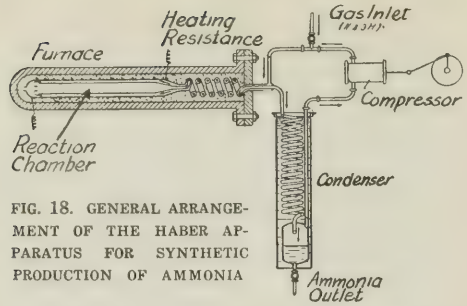


FIG. 18. GENERAL ARRANGEMENT OF THE HABER APPARATUS FOR SYNTHETIC PRODUCTION OF AMMONIA

took up the same. By a careful study of the equilibrium between nitrogen, hydrogen and ammonia at very high pressures, these inventors succeeded in finding the most favorable pressure and temperature relations for the formation of ammonia. Besides this they found that osmium as a catalyst had a great power to hasten the reaction and that thereby an NH_3 concentration of even up to 8 per cent could be reached. In their experiments to get the most suitable apparatus for their process the inventors were powerfully assisted by the Badische Anilin und Soda Fabrik and in this manner they succeeded in developing their process to a real commercial industry of great proportion.

The Haber apparatus, as far as it has appeared in the technical literature, is shown in Fig. 18, and concerning its description the reader is referred to Bernthsen's paper before the International Congress of Applied Chemistry, in New York, 1912.[2]

On account of the scarcity and high price of osmium, the Badische company has especially investigated various catalysts to find one cheaper but at the same time equally as effective as osmium. In this manner a number of technically possible catalysts have been found. What is at present used in the actual manufacturing processes in Germany is, of course, a secret, but the general guess is that it consists of iron, produced and treated in a special way.

In 1910 the Badische company could consider the technical side of the synthetic ammonia problem solved, and proceeded to the building of the first large factory for this purpose at Oppau, near Frankfurt. This plant had in 1913 a capacity, according to certain reports of 30,000 tons, and, according to others, 60,000 tons of ammonia sulphate per year. It is also quite significant of the belief by the Badische company in the Haber process, that beginning with the operation of the Oppau plant they withdrew the greater part of the capital (about 20 million Mks.) which they, in connection with the other German dye manufacturers, had invested in the Norwegian saltpeter industry.

FIG. 19. LINDE-FRANK-CARO APPARATUS FOR PRODUCING HYDROGEN

The raw materials for the Haber process are as mentioned, nitrogen and hydrogen. The nitrogen is produced by distillation of liquid air at a reported cost of only 3 to 4 pf. per kg. The hydrogen is produced from water-gas according to the Linde-Frank-Caro scheme, in that steam is led over incandescent coke, after which the water-gas thus obtained is purified from carbonic acid by absorption in lime. By cooling with liquid air the nitrogen and carbon monoxide are brought into a liquid state and in this manner separated from the hydrogen. By fractionation of the nitrogen-carbon monoxide solution, part of the nitrogen required for the synthesis is obtained and also fuel gas in sufficient quantity not only for this process itself, but also for driving the liquid-air machines for the nitrogen production. A sketch of the apparatus which is used in this method of producing hydrogen is shown in Fig. 19. The cost for the hydrogen is given as only 9 to 11 pf. per cubic meter or about 1 Mk. per kg.

According to a method for hydrogen production, invented by Bergius, in which superheated steam is allowed to act on iron at a temperature of 300 deg. C., it is claimed that hydrogen can be produced still cheaper, namely, for 40 pf. per kg. If, on the other hand, the process could be combined with some electrolytic process where hydrogen was obtained as a by-product, it would be even still cheaper. The cost of synthetic ammonia production, according to Muhlert,[3] is given in the following at different prices for hydrogen and nitrogen.

14 Kg. Nitrogen at 2 pf.	=	0.28 Mk. at 3 pf.	= 0.42 Mk.
3 Kg. Hydrogen at 40 pf.	=	1.20 Mk. at 100 pf.	= 3.00 Mk.
17 Kg. Ammonia	=	1.48 Mk.	= 3.42 Mk.
1 Kg. Ammonia	=	8.8 pf.	= 20 pf.
1 Kg. Nitrogen	=	10.6 pf.	= 24.4 pf.

The largest items in the cost of this process seem to be those covering the interest and amortization of the exceeding high first cost, and also the charges for repair and maintenance. It is claimed, however, with certainty, that ammonia can be produced by the Haber method at a considerably lower cost than with any other process in commercial operation.

The power consumption with the synthetic ammonia process is exceedingly small, so that the cost of power can almost be neglected in figuring the cost of production. Only about 0.5 kw.-hour is required per kg. ammonia, that is, not less than 10,000 kg. of nitrogen can be fixed per kilowatt-year.

OXIDATION OF AMMONIA

As before mentioned, incomparably the largest portion of the nitrogen required for ammunition purposes is used in the form of nitrates or nitric acid. All the above processes for nitrogen-fixation, which have ammonia as a final product, would, therefore, be of little value from a military point of view if no method existed for converting the ammonia into nitric acid. Thanks to the work of Ostwald, however, a comparatively simple and inexpensive method has been found for converting the ammonia and thereby also the free nitrogen in the air. For a long time it has been realized that the action of the fertilizers containing ammonia depends on the fact that the ammonia is converted into nitrates by means of an oxidation process in the soil. By Ostwald's catalytic oxidation process, however, it has been possible to carry out this trans-

[2] See also METALLURGICAL AND CHEMICAL ENGINEERING for April, 1913.

[3] Die Industrie der Amoniak und Cyanverbindungen, Leipzig. 1915.

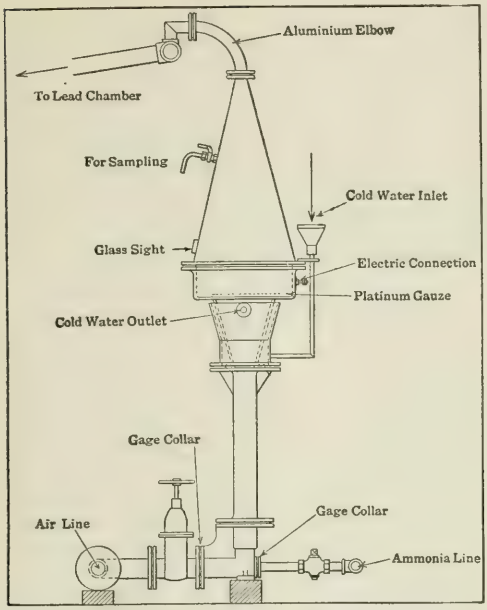


FIG. 20. OSTWALD CATALYZING APPARATUS FOR OXIDATION OF AMMONIA. OLDER TYPE

formation before the nitrogen is applied to the soil, which naturally has many advantages.

As an example of the reaction processes between ammonia and oxygen, the following formulæ may be of interest:

$$1—4NH_3 + 8O_2 = 4HNO_3 + 4H_2O$$
$$2—4NH_3 + 7O_2 = 4NO_2 + 6H_2O$$
$$3—4NH_3 + 5O_2 = 4NO + 6H_2O$$
$$4—4NH_3 + 3O_2 = 2N_2 + 6H_2O$$

In general, the reaction is regulated so as to proceed according to formula 3. Above all, it is endeavored to avoid the nitrogen losses of equation 4. The most generally used catalyst for this process is a fine-mesh platinum net, which is heated electrically to a temperature around 700 deg. C. It is claimed, however, that other catalysts, not containing platinum, are in use in Germany. The mixture of ammonia and air is led at a high velocity through the catalyst, so that the time of contact is only 1/100 sec.

An authentic view of an Ostwald apparatus, as it is now built, is not available. Fig. 20, taken from METALLURGICAL AND CHEMICAL ENGINEERING for 1916, shows an apparatus as actually built and intended for production of nitrous gases for sulphuric acid manufacture according to the chamber process, but this design deviates quite considerably from the design used at present. The illustration will, however, serve to give an approximate idea of what the machine looks like. As to their capacity, the earlier types were capable of producing 200 kg. 53 per cent nitric acid per 24 hours, but considerably larger apparatus are now built in Germany, where the process, as known, is now used to a very great extent.

From a technical point of view the Ostwald oxidation process has been considerably improved since it first began to be used on a commercial scale. In the first factory, at Gehrte, near Berlin, a nitrogen exchange of only about 75 to 80 per cent was obtained, while now 90 per cent is reached and even 92 and 93 per cent are claimed. Particularly on account of the fact that the catalyst gradually loses its activating power, an average value of 90 per cent may be considered conservative.

ECONOMICAL ASPECTS OF THE DIFFERENT PROCESSES

Having now briefly described the different methods for producing nitric acid from atmospheric nitrogen, a few words will be given in regard to the economic side of the problem. For some time there has been and is still quite a difference of opinion as to which one of the processes is the most economical and which one offers the greatest promise for the future. In particular this controversy has been with respect to the production of nitrogenous fertilizer materials. It would take too much space to go into this question, and I will only consider the manufacture of nitric acid with atmospheric nitrogen as a starting point, as this problem is in our case of a greater interest.

We will then first see how the price of nitrogen in its different forms stood before the war, and base our calculations on these prices. It must, however, be pointed out that the nitrogen prices will undoubtedly change quite considerably after the war, and the relation between the nitrogen values of the different products may also be quite different.

The prices in Germany before the war were about as follows:

Chile saltpeter, 95%— (15.5% N.)	= 185 Mk.	= 1200 Mk. per ton nitrogen
Ammonium sulphate 25%— (20.5% N.)	= 275 Mk.	= 1350 Mk. per ton nitrogen
Calcium cyanamid— 20% N.)	= 210 Mk.	= 1050 Mk. per ton nitrogen
Calcium nitrate— (13% N.)	= 156 Mk.	= 1200 Mk. per ton nitrogen
Nitric acid, 53%— (11% N.)	= 194 Mk.	= 1650 Mk. per ton nitrogen
Nitric acid, 93%— 20% N.)	= 390 Mk.	= 1900 Mk. per ton nitrogen
Ammonium nitrate— 35% N.)	= 610 Mk.	= 1750 Mk. per ton nitrogen

Using Chile saltpeter as a starting material and a saltpeter price of 185 Mk. per ton, it would be possible to manufacture and sell the concentrated 93 per cent nitric acid at a price of 390 Mk. per ton. We will now try to find what price we can figure with, for electric energy on the one hand and for the different materials required for producing ammonia on the other, in order to manufacture nitric acid at the same cost, both by the direct-arc method and by using the Ostwald oxidation method.

a. Birkeland-Eyde process:

Assumption: A factory with a yearly production of 10,000 tons = 2200 tons nitrogen. Cost of installation, 2000 Mk. per ton nitrogen per year.

The costs will then be as follows:

	Per ton Nitrogen
Interest and amortization, 15% on 2000	300 Mk
Labor	90 Mk
Misc. materials	70 Mk
General expense	100 Mk
Net cost of production exclusive of power	560 Mk.
Selling price per ton, nitrogen	1900 Mk
Balance for power and profit	1340 Mk
With a profit of 15% on 1900 Mk =	285 Mk.
the price of power (9.3 Kw. years) could be =	1055 Mk
Corresponding to a price of 113.4 Mk. per Kw. year	

b. Ammonia oxidation:
Same assumption concerning production, *i. e.*, 2200 tons nitrogen.
Cost of installation according to Diffenbach, 1500 Mk. per ton nitrogen per year.

The costs will then be as follows:

	Per ton, Nitrogen
Interest and amortization, 10% on 1500	150 Mk.
Conversion cost, exclusive of nitrogen losses but including concentration cost	500 Mk.
Net cost of production, excluding NH_3	650 Mk.
Selling price per ton, nitrogen	1900 Mk.
Balance for ammonia and profit	1250 Mk.
With a profit of 15% on 1900 Mk. =	285 Mk.
The price of the ammonia-nitrogen, 1100 tons, could be =	965 Mk.
Corresponding to a nitrogen price of 875 Mk. per ton.	

The calculations show therefore that in order to compete with the manufacture of concentrated nitric acid from Chile saltpeter at a price of 185 Mk. per ton, the energy for the arc process can not cost more than about 113 Mk. per kilowatt-year, or also, if the acid is to be manufactured from ammonia, this can not cost more than 870 Mk. per ton nitrogen.

The power value of 113 Mk. per kilowatt-year corresponds to 1.32 pf. per kilowatt-hour, a figure which undoubtedly can be reached in Germany with the modern gas engines and steam turbines.

Concerning the nitric acid manufacture according to the arc process in other countries with cheap water power, even if not as cheap as in Norway, it clearly shows that such a manufacture from an economical standpoint is much more advantageous than the production from Chile saltpeter.

If we now investigate in what ways we can produce ammonia with a nitrogen value of 875 Mk. per ton, we find that we cannot start out from ammonium sulphate as this has a nitrogen value in itself of 1350 Mk. per ton, or 275 Mk. per ton ammonium sulphate. At this price of ammonium sulphate, the nitrogen value of the ammonia liquor at coke or gas works can be assumed to be 1050 Mk., but in general this value is not taken higher than 850 Mk. per ton nitrogen. It would therefore not be profitable to convert this ammonia-nitrogen into nitric acid, if the nitrogen value in the concentrated nitric acid was not higher than 1900 Mk. per ton.

As far as the lime-nitrogen is concerned, its selling price in the German market has for the past years been around 200 to 210 Mk., corresponding to a nitrogen value of 1000 to 1050 Mk. per ton. At such a price it is evident that it would not pay to convert the cyanamid into ammonia and use this for the manufacture of nitric acid, when the conversion cost alone, the nitrogen losses inclusive, may amount to about 240 Mk. per ton nitrogen; that is, the nitrogen value in the finished ammonia would be nearly 1300 Mk. per ton.

It may therefore be said that the nitrogen in ammonia cannot cost more than 750 to 800 Mk. per ton; that is, 150 to 160 Mk. per ton 20 per cent. cyanamid, if the proposition shall pay.

With this, it should not be understood that it is entirely impossible, with a relatively high cost of power and a low cost of coke, to use the cyanamid-oxidation process for manufacturing nitric acid.

Looking into the possibilities of making nitric acd from ammonia produced according to the Haber process, we have here very meager data on which to base our assumption. The production cost of synthetic ammonia is, as previously mentioned, a secret, and only that part comprising raw material and power can be estimated with fair accuracy. According to what has been previously stated, the cost of the raw material should not have to exceed 24.4 pf. per kg. nitrogen, and the power cost can be figured at approximately 2 pf. per kg. nitrogen, or a total of 26.4 pf. We may, however, be on the safe side if we assume the other production costs to be 40 pf. per kg. nitrogen at the most, much lower figures having been reported. This then gives a total cost of 66 pf. per kg. nitrogen. If this estimate is fairly accurate, it shows that even under normal conditions synthetic ammonia can be converted into concentrated nitric acid at a good profit.

THE WARRING NATIONS' PROVISION OF NITROGEN

After the previous account of the natural nitrogen resources which are at the disposal of the warring nations, and the possibilities for utilizing atmospheric nitrogen, I will now endeavor to give an idea of how each country provides for its nitrogen requirements.

We will then begin with the entente countries, including America. Although this country as yet is not in open war* with the central powers, its nitrogen resources are entirely at the disposal of the entente. As previously mentioned, the nitrogen which is used for war purposes is principally in the form of nitrates or nitric acid, although smaller quantities in the form of ammonia-nitrogen are used, for example in explosives containing ammonium nitrate, etc.

The most important nitrogen source for the entente is therefore the Chile saltpeter deposits. By again referring to the diagram, Fig. 6, of the Chile saltpeter production, we can gain an approximate idea of how much the entente can obtain from this source. After a rapid decline in the production during the latter part of 1914 and 1915, the immediate cause of which was the stopping of the export to Germany, it reached in 1916 not only the record figure of 1913, but exceeded this by about 15,000 tons nitrogen. With exception of the small quantities which went to neutral countries, all of this was taken by the entente. It is difficult to estimate how large a part of this was used for fertilizers, but an approximate idea can be had by considering the different countries' saltpeter import before the war. We know, for example, that of 500,000 tons of saltpeter normally imported by America per year about 200,000 tons is used for explosives. Figuring, furthermore, 50,000 tons for other chemical industries, there remains for fertilizers about 250,000 tons. Assuming that this quantity has not been increased during the war, we would find that of America's import for 1916, amounting to about 1,200,000 tons, not less than 950,000 tons of nitrogen was used in the explosive industry. We know further that before the war about 80,000 tons of saltpeter was exported from Chile to other countries than Europe and America, principally to Japan, and possibly this was mostly used for fertilizers. During 1916 this figure rose to 140,000 tons, and the increase, 60,000 tons, corresponding to 9,500 tons nitrogen, can be assumed to have been Japan's contribution to the entente's ammunition supply. The normal shipments to Europe, not including Germany, immediately before the war amounted to 1,250,000 tons. It is generally

*Author's paper was read Feb. 8, 1917. The United States declared war in April, 1917, and subsequently planned for the production of nitric acid from the air.—Ed.

estimated that from three-fourths to four-fifths of the European saltpeter import is used for fertilizers, and from this it follows that the European agricultural industry, not including Germany, before the war broke out, used about 940,000 to 1,000,000 tons saltpeter. This figure has, possibly on account of the scarcity of tonnage, rather been reduced than increased during the war. During 1916 about 1,600,000 tons was shipped to Europe, and if we subtract from this the above fertilizer requirements the balance for explosive purposes would amount to from 600,000 to 640,000 tons, corresponding to from 95,000 to 100,000 tons nitrogen.

Adding together the above figures, we find that the entente during 1916 had more than 1,650,000 tons of saltpeter, corresponding to 260,000 nitrogen, for its production of ammunition, an amount which equalled the world consumption at the time of the Russia-Japan war.

The other large nitrogen source is, as before mentioned, the coal out of which nitrogen is obtained in the form of ammonia or ammonium sulphate. I have previously shown that of the world's ammonium sulphate production about one-third comes from England, one-third from Germany and one-third from the other countries, these proportions being before the war. While Germany's production has increased rapidly during the past years, England's production has remained at a little over 400,000 tons. America's production has shown a rapid increase since the war began and amounted to 325,000 tons in 1916. In the other entente countries it may be assumed that the production has fallen from about 140,000 tons before the war to from 75,000 to 100,000 tons, since a great portion of the Belgian and French coal fields have been captured by the Gemans.

The entente countries can therefore together be assumed to be able to produce over 850,000 to 900,000 tons of ammonium sulphate or 175,000 to 185,000 tons of ammonia-nitrogen. For their ammunition manufacture this is not of such great importance, as the conversion thereof to nitric acid is done to a very small extent. Only a few factories working on the Ostwald principle are in operation in England. Part of it, however, goes into the manufacture of ammonium nitrate, which is used for mines, bombs, etc. On the other hand, it is possible that part of the ammonia-nitrogen may indirectly benefit the ammunition production, in that part of the Chile saltpeter for fertilizer purposes can be substituted by ammonium sulphate, and that consequently the actual use of saltpeter is greater than figured above.

As to the utilization of atmospheric nitrogen for the manufacture of explosives, there are only two processes which to any degree can serve to fill the nitrogen demand of the entente countries. These are the arc and the cyanamid processes.

Of the arc processes that of Birkeland-Eyde takes unquestionably the first place. Although there are no installations of importance outside of Norway, large plants are planned both in America and Russia. As far as America is concerned, a great controversy is going on there at the present as to how the nitrogen question shall best be solved, the military authorities estimating that the yearly requirements for nitric acid in case of war would be 180,000 tons.

The product of the Norwegian factories, in which mostly French and English capital is invested, goes mainly to the entente. At present, since the Rjukan II plant has been put in operation, about 350,000 horsepower is utilized, which at a production of about 80 kg. nitrogen per horsepower year would correspond to 28,000 tons of nitrogen per year. Of this at least 20,000 tons goes to the entente, principally in the form of ammonium nitrate.

Washburn stated in 1916 that at that time about 500,000 horsepower was used in the manufacture of atmospheric nitrogen products for the entente powers. I suppose this included the power consumption of the Norwegian Nitrogen Company. If such is the case, it is possible that the largest part of the balance, 150,000 horsepower, has been used in the manufacture of cyanamid and would give about 50,000 tons of nitrogen. How much of this was used for explosives in the form of nitric acid is difficult to estimate, but the amount certainly was comparatively unimportant. On the other hand, a large part was undoubtedly used for the manufacture of ammonium nitrate, and we know that almost the entire Norwegian cyanamid production goes to the Norwegian Nitrogen Company's factories, where it is made into ammonia and treated with nitric acid for the production of ammonium nitrate, about 300 tons being produced per day. It is possible that both the French and the American cyanamid is used in the same way.

When we come finally to the question as to how the Central powers obtain their nitrogen supply, we have very meager data on which to base our estimates. We know only that it falls on Germany to obtain the required supply, and we know also fairly well what processes are used for that purpose.

As has been said previously, Germany undoubtedly had an enormous saltpeter stock on hand at the outbreak of the war, and it is claimed, besides, that as long as Italy remained neutral not inconsiderable quantities of saltpeter were imported that way. As soon as Germany found itself unable to keep up its saltpeter import an intensive activity was at once started for building up an atmospheric-nitrogen industry, large enough to supply Germany and its allies with their requirements. The means which were followed for this purpose seem to be as follows:

1. Increase of the ammonia production at coke and gas works.
2. Manufacture of ammonia by the cyanamid process.
3. Synthetic production of ammonia according to Haber's method.
4. Conversion of ammonia into nitric acid by the Ostwald method.
5. Manufacture of nitric acid by the arc process (Pauling's, etc.).

How large quantities of nitrogen products the Central powers have been able to obtain by the above methods is naturally very difficult to estimate accurately, and the reports in the technical press relating thereto are very meager and contradictory. The following can therefore only be a very approximate estimate thereof.

Considering first the ammonium sulphate, we find from an article in *Kunstdünger und Leim-Zeitung* for 1916 that Germany's ammonium sulphate production for 1917 is estimated to reach about 700,000 tons, or 140,000 tons of nitrogen. This figure, however, seems

to be entirely too low, because as previously pointed out (see Fig. 9), already in 1913 it amounted to 110,000 tons of nitrogen, and it is known with certainty that the distillation of coal has increased enormously since the beginning of the war. If we, however, take the value 140,000 to represent Germany's production, we may safely assume that the total production of the Central powers is fully 200,000 tons.

At the outbreak of the war there were in Germany and Austria six cyanamid factories with a combined capacity of 60,000 tons. The enormous expansion of this industry during the war follows also from the above article, which states Germany's cyanamid production during 1917 is estimated at 400,000 tons, corresponding to 80,000 tons of nitrogen. Several new factories also have been built in Austria and Hungary since the war started, and the total production of the Central powers in the form of lime-nitrogen may reach at least 120,000 tons of nitrogen.

As also previously mentioned, the first factory for the manufacture of synthetic ammonia according to the Haber process in 1913 had a capacity of 30,000 tons of ammonium sulphate. In 1915 the production was five times this, and for 1916 the production is reported as 300,000 tons, figured as ammonia. At least two new very large factories are at present under construction, so that for 1917 we can safely figure on an ammonia production of 500,000 tons, corresponding to 100,000 tons of nitrogen. In addition, there is one large factory being built in Austria.

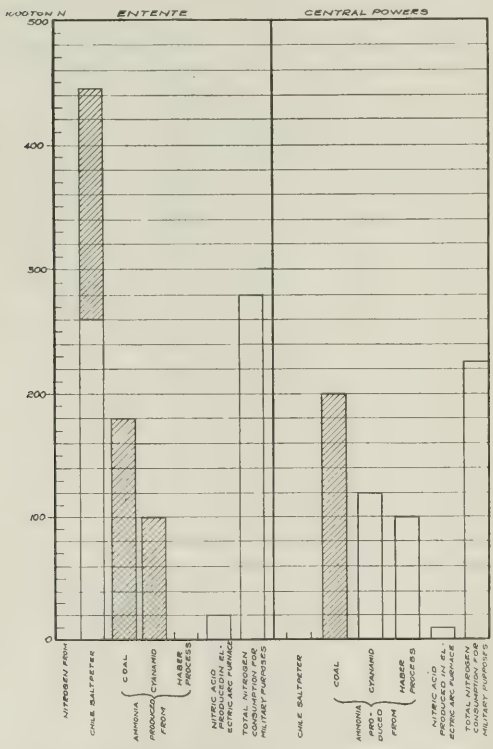


FIG. 21. GRAPHIC REPRESENTATION OF THE WARRING NATION'S NITROGEN RESOURCES. (THE SECTIONED PART OF THE COLUMNS REPRESENT THE NITROGEN USED FOR FERTILIZER.)

The Central powers' production of ammonia-nitrogen would therefore, according to the above figures, total 420,000 tons. What portion of this, in the form of ammonium sulphate or lime-nitrogen, is used for agricultural purposes is difficult to estimate, but it is very likely that the uses for this purpose have had to be somewhat reduced. Before the war 146,000 tons of nitrogen was used for this purpose in Germany. Assuming that, together, the Central powers at present consume 175,000 tons of nitrogen for fertilizing purposes, then at least 245,000 tons of ammonia-nitrogen would be available for military use, the greater part, however, only after it had been converted into nitric acid. On account of losses in this conversion, the above amount will have to be reduced by 10 per cent., that is, to 220,000 tons. This figure shows what enormous application the Ostwald process has found in Germany.

Finally, as to the arc process, the use thereof in Germany and Austria must be relatively small, as the supply of cheap power is scarce. Notwithstanding this fact, the process has come into use for the manufacture of nitric acid, although to a comparatively small extent. It is principally the Kock and Pauling methods which have been applied, steam and gas power being used for supplying the electric energy. According to one trustworthy source of information, not less than 100,000 horsepower should at present be used for this purpose, corresponding to a nitrogen production of 8,000 tons per year.

If the latter figure is included, the total available nitrogen supply of the Central powers for military purposes could therefore be roughly estimated as 225,000 tons per year, and the figure given by Landis in METALLURGICAL AND CHEMICAL ENGINEERING for 1916 is entirely too low. He estimates the saltpeter consumption for Germany at 100 tons of HNO_3 per day, equal to 80,000 tons of nitrogen per year.

In the diagram, Fig. 21, an endeavor has been made to graphically represent the above figures regarding the nitrogen resources of the Entente and Central powers. Without claiming any high degree of accuracy, this diagram can, however, serve to answer the question: "How do the warring nations obtain their nitrogen supply?"

Deterioration in Heating Value of Coal.—A report on the deterioration in the heating value of coal during storage, covering a five-year period, has just been issued by the Bureau of Mines, as Bulletin 136. Horace C. Porter and F. K. Ovitz are the authors.

The tests show that the amount of deterioration of coal in heating value during storage has commonly been overestimated. Except for the subbituminous Wyoming coal, no loss was observed in outdoor weathering greater than 1.2 per cent in the first year, or 2.1 per cent in two years.

The loss in heating value is given for New River and Pittsburgh coals during five years' storage in the open air and under water, for Pocahontas during two years' storage in the air, and for Sheridan, Wyoming, coal during two and three-quarters years' storage in the air.

The Bulletin can be obtained on application to the Directory, Bureau of Mines, Washington, D. C.

Present Progress and Development of the Electric Furnace in Non-Ferrous Metallurgy*

By Dwight D. Miller

Engineering Department, Society for Electrical Development

Regarding what has been and is being done to develop an electric furnace for use in the non-ferrous field, it can be said that there is under way at present much experimentation, though with not a great deal of actual accomplishment so far as the number of furnaces in commercial use is concerned.

The object of this experimentation is of course to develop an electric furnace which shall have not only high thermal efficiency but which shall be able also to handle yellow brass with small metal loss—and if possible one which shall be able to handle various alloys as the requirements of the foundry may demand. In working out this problem, simplicity in construction and reliability of operation should take precedence, since obviously a furnace which will operate continuously without electrical trouble or breakdowns, although it may not be quite as efficient as another type which is subject to these interruptions and delays, will turn out more metal of the desired quality for a given time and power consumption—will have the greater over-all efficiency of the two.

What is really needed to solve this problem is a combination of electrical and metallurgical knowledge. It is a comparatively easy matter for the electrical engineer to turn out a furnace which combines simplicity, reliability with high efficiency, one which will give ample heat for the process to be performed, but unless he knows just how the application of this heat at a certain temperature is going to affect the metals composing the alloys which volatilize at comparatively low temperatures, the metal losses of the process will be large. To correct this condition metallurgical knowledge is essential.

Alloys of low zinc content or those that melt at low temperatures do not present the same difficulty as do those with high zinc content which must be poured at the higher temperatures.

Dr. Gillett has explained the reason for this, namely, that since the alloys are poured at about 150°C. above their melting temperatures, those alloys which contain 30 to 40 per cent zinc are poured at a temperature but slightly below their boiling points with a vapor pressure of very nearly one atmosphere—hence the larger loss through vaporization.

There are a number of bright minds now at work on this problem, and it is to be hoped that practical commercial furnaces to meet the various conditions encountered in the non-ferrous industries will soon appear in addition to those already in use, thus establishing the electric furnace in the same permanent commercial position as it now occupies in the steel industry.

FURNACES UNDER EXPERIMENTATION.

The furnaces which have been designed and are now under experimentation include the Gillett furnace (indirect-arc type), patent assigned to the government, Department of Interior, Bureau of Mines; the Conley furnace (molded-resistor type), controlled by Florence & Hampton, 1270 Broadway, New York; the Thomson-FitzGerald furnace (reverberatory resistance type), controlled by John Thomson, 253 Broadway, New York; the Northrup furnace (induction type without iron core), controlled by the Ajax Metal Company, Philadelphia; the Hering "pinch-effect" furnace, controlled by Carl Hering, Philadelphia, although an option is held by the Ajax Metal Company for handling brass in the furnace.

The Gillett furnace, invented by Dr. H. W. Gillett, is an indirect arc furnace so designed as to bring about a violent agitation of the charge by a rocking motion. While the writer was privileged to witness some of the tests that have been going on during the summer, he is not in a position to reveal any of the results so far attained. It is hoped that Dr. Gillett will soon be in a position to make his findings public.

The Conley furnace, invented by William H. Hampton, is a resistance furnace of the molded-resistor type, in that the charge is melted in an open graphite crucible which closes the secondary circuit. The furnace is supported on trunnions and is poured by tipping through the mechanism of worm gears, chains and sprockets. It is balanced by counter-weights and can be tipped very easily.

The current is brought in by bus-bars and flexible cables, the ends of which are permanently connected to the sides of the crucible by graphite cement. This crucible is contained in a rectangular enclosure made of iron plates and packed with kieselguhr, the heating effect being obtained by radiation through the crucible walls.

The control is by hand-operated dial switches in the primary circuit giving varying voltage in the secondary, ranging from 10 to 20 volts. This method of operation gives a steady load, the only fluctuation which takes place being a very slight one due to the change in the resistance of the crucible as it heats up. The furnace is designed for single-phase operation at prevailing frequencies.

Some of the claims made by the inventor include: (1) A furnace which is revolutionary in the modern methods of melting, which can be used for melting any metals or making any alloys. (2) This construction gives absolute control over contents of furnace excluding all foreign matter, and accurate heat control—much more so than in the case of the arc furnace. (3) The melt is made faster with better product in that it is more homogeneous and can be held closer to specifications. (4) The total metal loss including volatilization and spillings is less than two-tenths of one per cent. (5) The furnace can be constructed to take a crucible of 1200 lb. capacity or larger and, while designed, as far as current-carrying capacity is concerned, to handle 20 kw. per 100 lb. melt, it is capable of melting 100 lb. of copper with 12 kw.-hr. input. The power factor is practically unity—98 to 99 per cent.

Regarding the Thomson-FitzGerald furnace, invented jointly by John Thomson and Francis A. J. FitzGerald, there is not at present a great deal to say, since it is not being pushed. The apparatus is designed for the purification of spelter containing deleterious metals by distillation in an electric furnace, and has been tested mainly for the fuming of impure zinc and condensing it as a highly refined metal. It is a resistance furnace

*Part of a paper presented at the meeting of the American Institute of Metals, Boston, Sept. 24, 1917. The introduction of the paper was reviewed in a report of the meeting in our issue for Oct. 1, 1917.

of the reverberatory type—the heating effect taking place by radiation from specially formed resistors and reflected to the charge from the walls and roof of the furnace inclosure. It is used in conjunction with a condenser into which the fumes escape through specially constructed passages.

Mr. Thomson advises that it is suitable for melting brass and bronze, which can be carried on simultaneously by subdividing the open retort; also that small melts of various alloys can be handled by crucibles set into the retort. For large melts the metal may be ladled out, tapped out or poured out through a spout by tilting.

The furnace underwent a series of tests at the Fitz-Gerald Laboratories, Niagara Falls, and while it was successful in producing extremely pure zinc, no other data are available for publication as to its performance. It has never been in commercial use in this country.

The Northrup furnace, invented by Prof. Edward F. Northrup of Princeton University, has been under experimentation for the past year, during which time considerable data have been obtained. The furnace is an absolutely new departure in furnace design and principle of operation. It is readily adapted to handle almost any kind of metal and uses an oscillating current at very high voltage, being stepped up to 10,000 volts. The oscillations are produced by discharges from a condenser and the energy conducted to a series of closed coils which are mounted concentrically and insulated from each other. These coils completely surround a cylindrical crucible in which the charge is melted. A 20-kw. furnace will melt 45 lb. of brass scrap in 35 minutes, starting from the cold. Temperatures as high as 1600 deg. C. are readily obtained. The furnace is admirably adapted to make melts in vacuum, and is now being used by the writer for melting both glass and electrical conducting materials.

Mr. Clamer of the Ajax Metal Company has the following to say about it: "Judging from the results thus far obtained with this type of furnace in its early development stage, it has very good prospects of becoming a commercially successful furnace for filling the gap in the fields covered by other electric furnaces thus far produced, i.e, that it will be an efficient melting device, having all the flexibility of the crucible melting furnace. It can be used with or without crucibles, does not require a liquid charge for starting, and it is therefore possible to empty the crucible entirely after each melting, making it possible to change readily from one mixture to another. As an exceedingly small amount of refractory material is required, owing to the large amount of energy which can be readily converted into heat in a small body of metal, the furnace reaches highest efficiency on the second heat. It is therefore a furnace which can be successfully used in 9 or 10-hr. per day service."

So far as the writer is aware nothing at present is being done with the Hering "pinch effect" furnace. The furnace has been fully described in the technical press both by Mr. Hering himself and others.

It will be interesting to note whether as these various furnaces are put into commercial use they actually meet the above claims which have been made on the basis purely of design or as the result of experimental tests.

FURNACES IN COMMERCIAL USE

The furnaces that are in actual commercial practice for handling copper-zinc alloys include the Ajax Wyatt furnace, controlled by the Ajax Metal Company, Philadelphia; the Foley furnace, controlled by Charles B. Foley, Inc., 170 Broadway, New York; the Baily furnace (reverberatory resistance type), controlled by the Electric Furnace Company of America, Alliance, Ohio; the Rennerfelt furnace (indirect-arc type), represented by Hamilton & Hansel, 17 Battery Place, New York; the Snyder furnace (direct-arc- type), controlled by the Industrial Electric Furnace Company, 53 West Jackson Boulevard, Chicago, and the Hoskins furnace (resistance type), controlled by the Hoskins Manufacturing Company, Detroit, Mich.

William A. Rogers Co., Ltd., states with reference to the Baily furnace that there are practically no metal losses handling silver, which is done in two crucibles holding approximately 500 oz. each, and that the metal appears more homogeneous—a better melt. They melt pure silver, copper anode scrap and chlorides, thus recovering the silver from their electrolytic process for plating. The first heat takes about 1 hour and 30 minutes, while the others take approximately 1 hour. The average total time for charging, melting and pouring being approximately 1 hour and 7 minutes, they can get about eight heats (of two crucibles each) in a day of 10 hours. The pouring temperature is around 2200 deg. Fahr., although no pyrometer is used, the temperature being judged by the color. They run with a constant input of 30 kw., which figures out 960 kw.-hr. per ton. The reason for the better melt obtained in the electric furnace is better control. They formerly used an oil furnace, but found that the quality of the oil varied considerably so that it was almost impossible to get uniform heating throughout the crucibles, necessitating pouring at 2500 deg. Fahr. in order to get good castings (flat blanks) as against 2000-2200 deg. Fahr. with electric heat. They also had trouble with water in the air pipes. By doing away with the oil pump and air compressor they were able to obtain much better insurance rates. The electrodes in the silver furnace are replaced once every three months; but as they use the butts left over from the annealing furnaces, this renewal costs them practically nothing.

Regarding the annealing furnaces, two of which are in use for annealing German silver and brass blanks, they can handle 9 tons in 10 hours annealing at 1450 deg. Fahr. with 175 kw., although the furnaces are rated at 200 kw. for this work. The current supplied to the plant is single-phase, 25-cycle, 440-volt. They have an arrangement whereby the current is supplied at a flat rate for a certain maximum 24-hour supply. In order to keep within this maximum they operate the silver furnace and motors in the plant during the day and the annealing furnaces during the night, which take 60-kw. when running full capacity. If, however, the motor day-load permits, the annealing furnaces are run during the day also at about 25-kw. input. Regarding the item of savings, this is considerable both in regard to pickling acid and labor required on account of cleaner metal.

The Otis Elevator Co. has two annealing furnaces, 300-kw. and 150-kw. capacity, for treating steel and brass castings. About the only trouble experienced has

been an occasional cracking of the resistor-troughs, necessitating patching. They operate these two furnaces from one three-phase transformer, the larger furnace operating two-phase and the smaller single-phase, the troughs of which are in series, thus producing an even balanced load.

The castings treated vary from 3 lb. up to 7000 lb. each. The larger furnace can handle a charge up to 12,000 lb. of metal, while 7500 lb. can be charged in the small furnace. The metal is treated at a temperature ranging from 1500 deg. Fahr. to 1850 deg. Fahr. and held anywhere from 16 to 20 hours. Starting with a furnace temperature of approximately 750 deg. Fahr. and running up to an annealing temperature of 1600 deg. Fahr. at which time the current was shut off, the cost per ton was approximately $7, the total time the power was on being 19¾ hours.

At the Lumen Bearing Co., Buffalo, they handle copper, lumen metal, phosphor and manganese-bronze. They charge 600 lb. consisting of scrap and ingots. Short test runs on both lumen metal and phosphor-bronze under far from ideal conditions resulted in a consumption of 12 kw.-hr. for lumen and 22 kw.-hr. for phosphor-bronze per 100 lb. They state, however, that as soon as they get running 10 hours per day of six days in the week they expect to reduce these figures to 10 and 17.5 kw. respectively based on making the hardener, used with lumen metal and forming 28 per cent. of the melt, separately in a crucible.

The lumen metal is poured from 1250-1600 deg. Fahr., the phosphor-bronze at approximately 2200 deg. Fahr. The heats average about one hour, so that eight or nine heats can be made in a 10-hour day, according to conditions. The metal loss will vary between 2½ to 3½ per cent for the lumen metal, the test on the phosphor-bronze showing 2 per cent.

With the idea of getting the hearth in good condition, a melt of copper, 1512 lb., was run just previous to the test run on phosphor-bronze. This was held for 4 hours and 20 minutes with a consumption of 24.8 kw.-hr. per 100, starting with furnace hot. The charging was done in nine separate lots extending over three hours, while six pours were made, ranging from 2000 deg. to 2100 deg. Fahr., in 40 minutes. Under these conditions the figures given should not be considered as a true indication of the performance of the furnace when handling copper.

It is possible to charge manganese-bronze immediately after a lumen heat, since the zinc which might be left in the furnace would have no injurious effect on the manganese bronze.

Of the two furnaces installed one has been in operation for six months and the other for two months. During this time there has been only one renewal of the bottom costing about $50, with some slight patching of same. The second furnace, however, is not run every day.

Regarding savings, the statement is made that with coke costing $4 and crucibles 4 cents per number there is a saving made by using electricity of ¾ cents per kilowatt-hour, which is practically what they pay. In addition the labor of carrying the coke and ashes is eliminated, together with the space for their storage.

In melting the alloys a small opening is left in the spout through which the vapor simmers out from time to time and is caught in hoods located permanently just above the spout. These hoods also carry off the escaping vapors when pouring.

By operating in this manner no pressure is built up within the furnace and it presents a rather nice question as to whether the metal loss would be less or greater when operating with a tightly closed furnace, building up thereby quite a pressure which causes the vapor to rush out with considerable force when the furnace is opened for pouring. The amount simmering out of the opening during the melt is trifling, since the zinc vapor is heavier than the atmosphere and is held by the saucer-shaped hearth of the furnace.

There is one more or less serious drawback to the Baily furnace in that it is very sluggish. It takes something like 15 minutes before it begins to respond to a change in power input, while as a matter of fact there isn't much change in temperature for an hour. At the Lumen Bearing Co. the last heat of the day is made on practically the stored heat of the furnace. In fact, it took them 49 hours to cool the furnace from 2580 deg. to 965 deg. Fahr. This sluggishness means that if the furnace is brought to too high a temperature in the morning at the beginning of the day's melt, the metal is apt to be burned and much time lost before the proper temperature can be obtained. On the other hand, it is of advantage in keeping a hot furnace overnight.

In connection with the other three furnaces in use, i.e., the Rennerfeld, Snyder and Hoskins, it can be said that they are of the indirect-arc, direct-arc and resistance types respectively. They have been fully described many times and are no doubt well known in both the ferrous and non-ferrous fields.

The Hoskins furnace is sold mainly for work of a more or less experimental nature as called for in the laboratory and testing room, or when it is desired to melt a small batch of metal occasionally. The manufacturers do not recommend it for commercial purposes.

They use two of their F. C. (crucible chambers) melting type furnaces continuously for melting their own nickel-chromium alloys. The smaller one takes one crucible No. 12 or No. 14 and the larger holds two crucibles of the same size. They give the following information regarding the performance of these furnaces:

"The smaller, holding one crucible, usually gives four to five heats of 23 lb. each per day, but we have no power figures on it. It is lined with 4½-in. magnesite back of the resistor and 4½-in. fire-brick back of this. This brick lining has to be rebuilt every six to eight weeks, and is patched every Saturday.

"The larger furnace, taking two crucibles, is lined with 4½-in. carborundum bricks just back of the resistor, with 3-in. powdered silica back of this, and finally 2½-in. kieselguhr brick back of this. This construction has to be rebuilt every three or four months, but it is patched every Saturday. In this furnace the current is turned on every morning at 4.30, increased at 7 a. m. to probably 40 kw., when charging begins, and later run at 50 to 60 kw. Five heats of 23 lb. each are usually gotten out per day, the first around 11 a. m. and the others every 1 1/3 to 1½ hours, using for the day from 450 to 525 kw.-hr. These alloys are poured at about 2900 deg. Fahr."

The results of five tests on yellow brass 65-85 showed an average of 49 kw.-hr. per 100 lb., pouring at 1950

deg. Fahr. The melt was made in a No. 70 crucible in their F C furnace. The total time per heat, outside of the first, which took 2½ hours, was approximately one hour. Eight tests on red brass showed an average of 36.5 kw.-hr. per 100 lb., pouring at about 2150 to 2175 deg. Fahr. The first and average heat took the same time as for yellow brass. No metal loss was given in either case. The temperature was taken with a Hoskins couple bare.

The only installation of Snyder furnaces handling non-ferrous metals of which the writer is aware is that of the Chicago Bearing Metal Co. There are two furnaces installed there rated at 400 kw., each taking approximately 750 kva., single-phase, 60-cycle, directly from a 12,000-volt line. The secondary line voltage is 220 with an operating voltage from 120 to 160 volts, depending upon conditions. The power factor is in the neighborhood of 60 per cent.

The furnaces have a capacity of about 2000 lb. of metal per heat and the average power consumption is not over 300 kw.-hr. per ton. They operate 24 hours per day, Sundays excepted, and handle a heavily-leaded bronze such as is used for railway car and locomotive bearings. The composition of the metal is approximately 75 per cent copper and the balance lead, tin and miscellaneous impurities in that order of importance, the lead running about 15 per cent. The metal is poured at approximately 2100 deg. Fahr., and while the metal loss is fairly high, mostly lead and some copper, they save about $12,000 net per month by doing away with the crucibles, since these two furnaces replace forty to fifty coke and oil-fired furnaces. The high metal loss follows naturally from the use of a direct arc furnace, since it is bound to produce a superheated top layer in the bath. There is also a saving made in increased production with smaller floor space. No further information is available as yet.

The Rennerfelt furnace is in operation at the Gerline Brass Foundry Co., Kalamazoo, Mich., 1/3-ton capacity, and at the Philadelphia Mint, 1200-lb. capacity, while two more of 1-ton capacity each will shortly be in operation at the Chicago Bearing Metal Co.'s plant. These furnaces are all designed for two-phase, three-wire operation.

The furnace at the Philadelphia Mint has been in operation only for a short time, so that full data are not available as yet. They handle penny stock and cupro-nickel. The penny stock is composed of 95 per cent copper, the other 5 per cent being made up of zinc and tin. The cupro-nickel is composed of 75 per cent copper and 25 per cent nickel. They make three heats per day, pouring the penny stock at approximately 1950 deg. Fahr. and the cupro-nickel at about 2500 deg. Fahr.

They have also handled some French and Italian coins composed of almost pure nickel, the lining standing up very well, although the melt was at a high temperature. They use a ganister bottom with silica-brick linings. This furnace should give a very good account of itself in handling alloys of this nature.

In the furnace at Gerline Brass Foundry they have been handling red brass, enamel tank (one-half red and one-half yellow brass with not over 22 per cent zinc content) and monel metal, but not much success was attained with yellow brass ingots. They could not handle yellow brass borings at all. This was to be expected, since neither the direct or indirect-arc type of furnace is suited for handling alloys containing metals which volatilize at comparatively low temperatures, unless some method is provided for overcoming the superheated top layer.

They had some trouble with the lining giving out on the monel metal heats, which, however, might be attributed to lack of skill in operation rather than against the lining itself, in that the metal was melted to a very high temperature (around 2000 deg. Fahr.) in order to pour intricate castings, and the furnace was over-powered. This would seem to be borne out by the fact that nickel was successfully melted at the Philadelphia Mint in the same lining. They also had trouble with deposits of zinc oxide on the carbons just where they passed through the furnace inclosure, causing them to "freeze" so that they could not be moved in or out.

While too much reliance should not be placed on operating figures obtained as the result of experimental runs, and this remark will apply to those previously given, still as an indication of what may be expected the following results are given:

Out of four heats making monel metal castings, three showed no metal loss and the fourh heat a loss of 3.3 per cent. The average of the actual melting time was 3 hours and 48 minutes, with a consumption of approximately 1300 kw.-hr. per ton. The average charge was 549 lb. with an average electrode consumption of 5 lb. per ton.

The result of seven heats making enamel tank castings under fair operating conditions showed an average metal loss of 3½ per cent, with an average of actual melting time of 1 hour and 48 minutes. The average consumption was 537 kw.-hr. per ton, while that for electrode consumption was 2.8 lb. per ton. The average charge was 580 lb. A great many more heats were run on this alloy, but as the records included preheating of furnace, delays, and gave no metal losses, they were not included.

Ten heats were selected from those making red brass castings as representing fair working conditions. The results show the average charge to be 532 lb. with an average of actual melting time of 1 hour and 14 minutes. The average kilowatt-hour consumption was 437 kw.-hr. per ton with an electrode consumption of 2.8 lb. per ton.

It will be noted that the kilowatt-hour required for making red brass castings are less than those for enamel tank, and simply goes to show that experimental figures cannot be relied on for commercial practice. No metal loss was given for these heats, nor were any pouring temperatures given for any of the tests, which help to explain the discrepancy in the results obtained. The enamel tank may have been heated to a much higher temperature. In order to obtain figures of value full, complete data as to all conditions entering into the test should be accurately recorded.

Regarding the whole question of labor savings, it can be stated that arrangements have already been worked out whereby pouring castings or blanks direct from the furnace can be accomplished. In the case of small furnaces these can be picked up bodily and brought to the pouring floor, while in the case of the larger furnaces the molds can be arranged to pass under the spout by means of a conveyor system. An additional advantage to be gained by such practice is the elimination of heat and metal losses when pouring from a ladle.

It will be noted that very little use is made of the pyrometer for accurately recording the temperature of melts. This, in the opinion of the writer, is a mistake and much to be regretted, since the primary object of the use of the electric furnace is to reduce metal losses by more accurate control and the keeping of full and complete daily records which can be used in determining the best practice and eliminating preventable losses. In accomplishing this object the thermo-couple used for measuring temperatures in conjunction with either an indicating or recording instrument is of extreme importance.

One of the objections to using a pyrometer seems to be that accurate temperatures cannot be obtained quickly; that is, by the time the couple has been inserted and a reading taken the metal has fallen off 100 or 200 deg. As already indicated, it is perfectly possible to install the couple permanently in the furnace so that reading can be taken at any time by connecting it with the temperature recording instrument. This should do away with the above-mentioned objection.

This résumé covers fairly completely what has been and is being done, so far as the writer has knowledge, toward the development of an electric furnace for use in non-ferrous metallurgy. The results recorded as to performances are not as full as the writer would have liked to obtain, but it was extremely difficult to obtain them, due to the lack of keeping accurate records. It is to be hoped that the importance of so doing will be fully realized, in order to improve the general practice of to-day. From all indications it is fair to assume that the electric furnace will soon be established on a firm commercial basis as a heating medium in this field.

Ten Per Cent More Coal Will Be Produced in U. S. This Year Than Last.—The Fuel Administration authorizes the following:

Coal production in this country this year will exceed that of last year by 10 per cent. The embargo against sending coal to Canada has been lifted and an arrangement made by which she is to be supplied on a pro rata basis, substantially as though she were a State of the Union. The American Northwest will be properly supplied.

These are of conferences announced recently by Federal Fuel Administrator Harry A. Garfield before his departure for Williamstown. Those present at the conferences were Dr. Garfield; Judge John F. McGee, State fuel administrator for Minnesota, representing the Northwest; W. H. Groverman, representing the dock interests on Lake Michigan and Lake Superior; F. C. Baird, commissioner of the Lake Erie Coal Exchange; and H. P. McCue, assistant fuel controller of Canada.

Not only will this year's coal production exceed that of last year by 10 per cent, but it will exceed that of two years ago by 23½ per cent. These are the figures given Dr. Garfield by Prof. George O. Smith, of the United States Geological Survey.

"The question of shortage for this year," said Dr. Garfield, "will depend then upon whether the American demand has increased by more than the 10 per cent increase in production. If our industrial development, from the war and other causes, has grown beyond that, then we must go short. We have no figures to tell what that development has been."

Chemicals Used in Ore Flotation*

By Oliver C. Ralston† and L. D. Yundt‡

The flotation of minerals from ore-pulps, as practiced at present, involves the use of a small amount of a flotation oil, which so modifies the water in the pulp that a froth is formed and that certain valuable minerals are gathered in the froth. The froth must have sufficient persistence to allow time for separation from the body of the residual ore-pulp. This paper does not deal with the subject of flotation oils, but rather with the other chemicals which are occasionally added to ore-pulps for one reason or another.

The development of ore flotation in a few years to a stage where over 100,000 tons of ore are treated every day in the United States, and half as much again in the rest of the world, threatened, for a time, to disastrously upset market conditions for various products such as pine oil, coal creosotes, coal tar, etc. Incidentally, flotation has also opened a market for other chemicals which formerly could not be used in the western intermountain districts. Chemical engineering has never flourished in these districts on account of the smallness of the market, but it is hoped that ore flotation will now open up new fields for the chemical engineer. The signs of the times point toward the speedy developmnt of sulphuric acid plants at various smlters which are now wasting their sulphur in smoke, and on these plants many other industries will depend. Certain other chemicals will not require sulphuric acid in their manufacture but will soon find a market in these regions, due to the demands of flotation mills and of hydrometallurgical plants.

I shall outline briefly the most important of these chemicals and attempt to set forth the reasons for their use or the theories as to why they have certain definite effects.

ACIDS

Almost the only acid used for flotation work is sulphuric acid which costs less than most of the other available commercial acids. No one knows why the addition of sulphuric acid to certain pulps improves the flotation work. We do know that it often produces a cleaner flotation froth containing less gangue, and also that higher extractions are often made. Further it can reduce the amount of oil necessary to produce the same frothing effect. However, the addition of acid to an ore pulp sometimes proves fatal to good flotation, especially with some copper ores in which a part of the copper has been oxidized by weathering. Such an example is the ore at Inspiration, Arizona. In this latter case the trouble may be due to the formation of enough copper sulphate to spoil flotation, copper sulphate having been found deleterious in the flotation of a number of copper ores. The oxidized copper minerals dissolve easily in very dilute sulphuric acid solutions while the natural copper sulphides are not attacked.

When the addition of sulphuric acid causes an improvement in the flotation of a definite ore, its exact function is rather a difficult thing to explain, and theories are very conflicting. The phenomenon has been known since the very early development of the art. The

*A paper read at the Boston meeting of the American Chemical Society, Sept., 1917. Published by permission of the Director of the Bureau of Mines.

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‡Metallurgical Research Fellow, University of Utah.

Potter-Delprat processes depend on the acid to develop bubbles of gas through interaction on the carbonate minerals in the ore (such as calcite) in order to form a froth, and bubbles of air were not beaten into the pulp. Consequently it was natural that some of the early theories claimed that the addition of acid to a pulp being treated by air flotation, caused an increased number of gas bubbles to form in the pulp and hence facilitated frothing out all the desirable mineral particles. The fallacy of this argument has long been felt.

Electrostatic theories have been advanced to explain flotation and the statement has been made by one theorist that the addition of an electrolyte to the water of the pulp allowed the electrostatic charges on the gangue particles to be conducted away while the charges on the particles of the desired minerals were insulated by a surrounding film of flotation oil. This electrostatic theory was soon exploded, as it rested on a misapprehension as to just what caused charges to appear on suspended particles. The surfaces of small particles suspended in a liquid usually tend to absorb more ions of one electric sign than of the other sign and hence carry apparent electrostatic charges. The thing to be noted, however, is that these charges on the particles are not conducted away by the presence of electrolytes but their existence is dependent upon the presence of ions in the solution. The surface of oil droplets and of air bubbles like absorb ions from solutions, and a certain parallelism between the charges on these various particles of matter and the conditions of good flotation has been observed. Just what is the inner connection has never been explained. It is an interesting fact that one mill in Colorado was reported to receive very pure water from melting snow and that flotation of its ore in this water was very unsatisfactory until the water was contaminated with an electrolyte, sulphuric acid being acceptable among other things.

Bancroft* calls attention to the fact that the acid in ore flotation may not react because of the replaceable hydrogen atom but because of the cutting down of the concentration and consequently the adsorption of the hydroxyl ions. The connection which he wishes to draw with flotation is that "in acid and neutral solutions air seems to be absorbed by organic liquids much more readily than by water," and he thus derives a reason for the attachment of the air bubbles to the oiled sulphides. The preferential adhesion of the oil to the valuable sulphide minerals in the presence of gangue minerals is well known.

The surface tension theories have claimed that the addition of the proper electrolytes, like sulphuric acid so alters the surface tension of the water that frothing can take place. This may be true without conflicting with the colloidal theory but we would call attention to the very small amounts of acid which sometimes produce a marked effect on flotation and the small resulting changes in surface tension of the water. Small amounts of electrolytes are sometimes known to produce profound changes in colloids and we feel more inclined toward the colloidal theory.

Nevertheless, it is not right to claim that the replaceable hydrogen atom has nothing to do with the improvement in flotation results when acid is added. Allen and Ralston* have called attention to the fact that if an ore sample is ground dry it is usually necessary to use acid in its flotation, while it is often possible to grind this same ore in a wet condition in a ball or pebble mill and obtain the same flotation results without the use of acid. The natural inference is that the dry grinding has caused oxidized films to form on some of the particles of natural sulphides and that the sulphuric acid was needed to dissolve these films, leaving a clean unaltered surface for the action of the flotation oil and the air bubbles. This, of course, is only a special case and does not claim exception to the colloidal theory in the least.

The amounts used are usually the minimum which have been found to produce a given effect. It varies from two or three pounds of sulphuric acid per ton of ore (contained in three to five tons of water), to as high as one or two hundred pounds of acid. When a large excess of acid is necessary we feel that it must be dissolving off oxidized films while small amounts of acid are probably effective in causing selective adsorption effects. Acid seems to be necessary in the flotation of many sphalerites and iron pyrites. Occasionally a pyritiferous copper ore needs acid. The Anaconda slimes constitute an example of such an ore. The present tendency among flotation men is to find substitutes for acid.

COPPER SULPHATE

So much has been said about the "flotation mystery" involved in the improved results obtained at the Mascot, Tennessee, plant of the American Zinc, Lead & Smelting Co., that a word should be said here. There is no doubt that the use of less than one pound of copper sulphate per ton of ore, suspended in over four tons of water, has caused very much increased recoveries of the sphalerite in their ore and allowed cleaner work. The same effect has been noticed in many other mills treating zinc sulphide ores, although an improvement in the flotation is not necessarily the invariable result of adding copper sulphate to zinc sulphide ores.

At Mascot, the large scale plant was unable to produce commercial results on the ore which had yielded good results in laboratory tests. A bucket of pulp taken from the mill and tested in the laboratory gave good results where the mill failed. At last it was realized that the bronze castings used in the laboratory machine might account for the difference and the hanging of a plate of copper in the mill pulp while it was passing through the large flotation machines corrected the difficulty and led to the discovery of the effect of salts of copper on the flotation of sphalerite. The method by which this discovery was made deserves commendation.

So much then for the fact. Copper sulphate added to the pulp improves the flotation of sphalerite, but it has been called a flotation mystery because no one could explain it. Copper sulphate is deleterious in the flotation of silver ores† and of copper ores; its effects being overcome by precipitation with such a reagent as hydrogen sulphide, sodium sulphide or sodium carbonate.

Neither silver minerals nor copper minerals precipitate copper ions from solutions, but it is well known that natural zinc sulphide reacts with copper sulphate solu-

*Wilder D. Bancroft, "Ore Flotation," Met. & Chem. Eng., 14: 631 (1916).

*Mining and Scientific Press, Jan. 1 and Jan. 8, 1916.
†Min. & Sci. Press, Dec. 18, 1915, An Occasional Correspondent. "Effects of Soluble Components of Ore on Flotation."

tions, precipitating copper sulphide. In fact this reaction is used in the Huff electrostatic separation process for separating zinc sulphide from minerals of the same specific gravity and which are likewise poor electric conductors, such as barite. By soaking the mixture of minerals in a dilute copper sulphate solution a thin imperceptible film of copper sulphide is formed over the zinc sulphide particles and after drying they then act like good conductors and can be caused to jump off of the electrostatic separating machines, leaving the barite behind.

The suggestion is inevitable that in the case of improved flotation of sphalerite the copper going into solution is precipitated as copper sulphide on the surfaces of the zinc sulphide particles, making them capable of better flotation. Why the modified particles float better is the true mystery. Whether the increased electric conductivity of the surfaces of the particles has anything to do with it, or whether copper sulphide has some inherent property of being more easily "oiled," is hard to say. Some rather simple experiments in the physical laboratory might well be suggested by what has been said above.

Some other effects which have not been previously recorded have been reported to me by F. G. Moses, of the General Engineering Co. He had observed the appearance of the tailing from the flotation machines, treating a sphalerite, when it was passed over a slime-table (as a pilot to indicate the work of the flotation machine by the size of the concentrate streak produced). Before the addition of copper sulphate the slime of the tailing seemed impalpable but afterwards it had the appearance of curdled milk (flocculated). However, in a second mill the slime in the tailing still seemed to be deflocculated. In both instances the finely ground zinc sulphide in the concentrate seemed to be flocculated and in the second case the grade of the concentrate was raised considerably by passing it through a drag classifier from which some of the deflocculated gangue slime could overflow. This observation by a young engineer who kept his eyes open may be of a great deal of importance. I have often noticed the flocculated condition of the concentrate in flotation froths, but had been inclined to attribute it to the oil which supposedly collected the material into small units. Evidently the copper sulphate could assist in this flocculation, for it is well known that heavy metal ions are strongly adsorbed. In colloid chemistry it is usual to find very small amounts of such chemicals producing striking effects and it is probable that the extremely small amounts of copper sulphate involved in the case at hand are sufficient only for some colloidal reaction, be that what it may.

The condition of the concentrate and gangue particles, with regard to their degree of flocculation, has not been sufficiently investigated and we are hence confronted with the necessity of determining just what becomes of the copper introduced into such ore-pulps. Is it precipitated as copper sulphide or is it adsorbed?

LIME AND ALKALIES

Of late there has been a tendency to use various alkalies as addition agents in flotation, with the result that in many places they are competitors of acid. Of course, the best thing to do, if possible, is to find an oil mixture that will not call for any addition agent, but as long as the use of these further addition agents increases the extraction of the desired mineral or improves the grade of the concentrates enough to more than pay for the amount of addition agents used, they will not be displaced. The use of alkaline addition agents has advantages in lessening the corrosion of the machinery and often diminishes the amount of oil necessary. With alkaline pulp the oils can be added to the pulp ahead of the final grinding machinery so that the tube or ball-mills can be caused to disseminate the flotation oil before the pulp reaches the flotation machinery.

Few people have reported any observations on the phenomena produced by the use of these additional agents beyond the improvement of the metallurgical results. There is no doubt but that soluble heavy-metal salts are precipitated by the use of these various alkaline substances and it is also well known that these heavy metal compounds are often deleterious to flotation, so that their removal by precipitation is imperative. Whether more than the amount of alkaline agent necessary to react with the deleterious salts should be added is not known. It is known that in a number of instances it has been possible to float a "tarnished" ore by the addition of various alkaline sodium salts where the same flotation oils did very little good when used on the ore alone. If sodium sulphide were the alkali used this would not be surprising as it could be easily seen that the sodium sulphide would react with copper carbonates and other oxidized minerals, forming sulphides and thus causing their flotation. But when sodium hydroxide brings about the same results it makes it seem possible that the thin films of oxidized material are dissolved off of the faces of the natural sulphide particles. This would be possible with zinc, copper or lead ores since the hydrates of these metals are somewhat soluble in sodium alkaline solutions. Instances of improvement of the grade of work with ores containing each of these metals are known. I have not heard of many instances of the improvement of the flotation of pyrite by the use of such addition agents. British patent 5856 of 1914, granted to Minerals Separation and DeBavey's Processes Australia Proprietary, Ltd., states definitely that in the flotation of such tarnished ores the water in the circuit should be distinctly alkaline toward phenolphthalein. Sodium carbonate is the alkali preferred.

The use of caustic soda at a number of mills has resulted in some degree of satisfaction, especially with the porphyry copper ores. At the September, 1916, meeting of the American Institute of Mining Engineers, during the discussion of one of the papers, it developed that the Old Dominion mill at Globe, Arizona, was using caustic soda to the amount of 1 lb. per ton of ore. According to the metallurgist, Mr. Cramer,* this resulted in a much less viscous froth which tended to lay more flatly in the flotation machine and was more easily broken down and ran more easily in the froth launders so that not so much water was required. This, in return, allowed better work in the overworked Dorr thickeners, where the flotation concentrate was thickened before filtering. Further the extraction was somewhat increased, the grade of the concentrate was raised and hence less "insoluble" was left in the concentrate. At still another mill a reduction in the flotation oil necessary also resulted.

*Trans. Am. Inst. Min. Eng., Bull. 119, p. 1891, Nov., 1916.

It is noticed that such alkalies cause a weaker and more mobile froth. The effect of the addition of alkali to a ball of stiff clay lying on a board is well known. A drop of alkali will cause the clay to flatten out whereas the same amount of water does not. The alkali deflocculates the clay so that it "liquifies." The cause of the decreased viscosity of the froth in a flotation machine is hence easily understood. The higher extraction of the desirable mineral is also easily explained, because the alkali tends to deflocculate the gangue slimes and therefore any desirable mineral particles intrained in the gangue will be liberated and become available for flotation. As a result of this not so much excess of flotation oil and agitation will be necessary in the attempt to mechanically break up the gangue particles and bring the oil in contact with the sulphide minerals. Not so much air being necessary to bring the mineral particles to the surface there will not be such a large proportion of mechanically intrained gangue in the froth concentrate. In other words, all the effects above noticed can be explained on this assumption.

Of the various alkalies used, caustic soda, sodium silicate, sodium carbonate, sodium sulphides and lime are the principal commercial ones. Sodium silicate is a more powerful deflocculant than sodium hydrate, possibly due to a protective action of the colloidal silicic acid formed in dilute solutions. It was used for a while with success in the flotation plant of the Utah Leasing Co., but was later displaced by sodium carbonate. Our own experience with many different types of minerals, at the Salt Lake station of the Bureau of Mines, has been that sodium carbonate is the most desirable alkali as it does not tend to so permanently deflocculate the gangue slimes, allowing easier thickening and filtration of the flotation concentrate and tailing.

A rather surprising claim is made in U. S. Patent 1,203,341 of Oct. 31, 1916, granted to Allen C. Howard of the Minerals Separation Co. He claims that if alkaline substances are made up into a strong solution and the proper amount dripped into the first cell of a series of flotation machines a better result is obtained than where the circuit water which contains the ore is already alkaline to the same extent. Attempts to check this claim by experimentation in our laboratory have failed to justify it. The patent claims that in the mill of the Caucasus Copper Co., in the Caucasus, Southern Russia, this effect is quite marked. We fail to understand just how this can be so, and think that the patent is actually attempting to claim the use of these alkalies in the manner in which they are most naturally used—in the form of a strong solution, the proper amount of which is dripped into the pulp at the most convenient point in the flow-sheet. To avoid infringing the patent the alkali would have to be previously mixed with all the mill water before the ore was ground in it, which might easily prove more expensive and less easily performed.

Lime is not such a desirable addition agent as the alkaline sodium compounds and while it may cause desirable effects when added in small amounts, an excess is often harmful. Lime and most other calcium compounds are usually flocculators of gangue slime, rather than deflocculators as the alkaline sodium compounds are. This may explain the difference between the two, although it has been continually hinted that we know entirely too little about the condition of flocculation of the ore pulp during flotation. It is very probable that in the cases noticed where lime improves the flotation it functions in precipitating other less desirable soluble impurities such as iron sulphates. At the Miami mill it was found that if lime were added to the pulp before entering the ball mills a somewhat increased extraction resulted, whereas the addition of lime directly at the head of the flotation cells resulted disastrously. Supposedly the lime had to be allowed time enough to react with all the soluble or semi-soluble impurities of the pulp before going to flotation so that there would be no raw caustic lime to cause trouble.

Sodium sulphide and calcium sulphide or polysulphides are used in the flotation of oxidized ores of lead and copper. Hydrogen sulphide is also in use for the same purpose in the flotation of copper sulphide ores. The oxidized minerals are "sulphidized" by these chemicals and can be floated in the same manner that the natural sulphides can be floated. However, there is no objection to using sodium sulphide or the other sulphides to precipitate soluble heavy metal salts from solution. Hence these soluble sulphides can serve a double function. Three mills are now in operation using sodium sulphide, in the sulphidizing of lead carbonate ores, and several copper mills use it for oxidized copper compounds. The method is fairly satisfactory because only small amounts of the sodium sulphide are used, the lead carbonate particles being merely coated superficially with a film of lead sulphide which can be oiled and floated. As little as 3 lb. sodium sulphide per ton of ore, containing 15 per cent lead, is successful in causing the flotation of over 90 per cent of the lead minerals. In case the ore contains manganese dioxide, basic iron sulphates or lead peroxide minerals these tend to use up the sodium sulphide before the lead carbonate is satisfactorily sulphidized. Since such minerals are fairly common in the oxidized ores of lead the method can be applied to only those ores which are free from such constituents. Hydrogen sulphide is in use in the mill of the Magma Copper Co., at Superior, Arizona, sulphidizing copper carbonates.

Of all the alkaline compounds mentioned above, lime is the cheapest but not the most desirable. Sodium carbonate is not only highly desirable but also can be obtained more cheaply than most of the other sodium compounds. In fact most of the flotation work which calls for the use of sodium carbonate is situated in the intermountain region not far distant from the alkaline lakes and natural trona deposits of the arid and semi-arid regions. An outlet for the sale of this crude natural soda has long been desired. At the present time most of the soda in use by flotation mills is shipped in from the east and is much purer and more expensive than the work demands.

Sodium sulphide also costs too much when delivered into the intermountain country from the middle west or the east. It can be made from niter cake or from sodium sulphate by reduction. Sodium sulphate is available in a fair degree of purity from deposits on the bottom of Great Salt Lake or from Searles Lake in California.

ORGANIC ACIDS

Organic acids, like tartaric acid, citric acid, etc., and their salts, have been mentioned in British Patent 17,327 of 1914, granted to Geo. A. Chapman, one of the

Minerals Separation engineers. Argols, the crude tartrate of potassium, was added to the pulp in both the Anaconda, Montana, and the Burro Mountain, New Mexico, mills which are treating copper ores. The argols were introduced into the pulp as it entered the tube mills, in amounts ranging from one-tenth to one-fourth of a pound per ton of ore. Both of the ores mentioned are noted for the high percentage of colloids present, due to clay-like minerals in the original ore. The flotation results were said to be greatly improved. The effect of the tartaric acid seems to be a slow flocculation or coagulation of the gangue slime.

These organic acids and their salts are known to have low dissociation constants, and the theory advanced in Chapman's patent is that these reagents do not flocculate the gangue slime so quickly but that the sulphide minerals escape entrainment in the flocs so that they are collected by the oil and air into the froth before flocculation of the gangue. To quote the words of the patent, "The effect of electrolytes upon colloids (as is known) depends *inter alia* upon the valency and upon the ionizing power or dissociation constant of the electrolyte. Tartaric acid is divalent and as compared to ordinary mineral acids it has a low dissociation constant. Citric acid has similar properties but is trivalent.

Many other electrolytes such as organic acids and their salts also have similar properties as electrolytes and the choice of a suitable electrolyte for the purposes of this invention can be readily determined by a preliminary test.

This is a most interesting theory but I have noticed that citric acid, which is mentioned above, usually does not flocculate gangue slimes but rather exerts the reverse effect. It is probable that the effects of organic acids in flotation will be found to be as erratic as their absorption effects commonly known to colloid chemists.

SILICOFLUORIDES.

British Patent 4938 of 1914, granted to Sulman and Minerals Separation, calls for the use of silicofluorides as a substitute for acid in the flotation of ores. It is claimed that these compounds give the desired results. The complex fluorine salts have rather unusual ionization and other chemical constants, and hence it might easily happen that the effects on flotation would be unusual and hard to predict. The diversity of the various compounds mentioned as having been patented by the Minerals Separation Co. shows how far their engineers and chemists have gone in developing the process of flotation.

A test of Broken Hill (Australia) tailing was made in London tap water without the addition of potassium fluoride and another test was made with this addition agent present to the extent of 3.4 lb. per ton of ore. The oil used in each test amounted to 2.0 lb. of eucalyptus oil per ton of ore. The data on the two tests were as follows:

	Ordinary Flotation	With Silicofluorides
Heading	Zinc 19.0%	Zinc 19.0%
	Lead 7.0%	Lead 7.0%
Concentrate	Zinc 29.0%	Zinc 36.1%
	Lead 9.3%	Lead 14.7%
Tailing	Zinc 14.4%	Zinc 4.8%
	Lead 2.5%	Lead 1.6%
Recovery	Zinc 56.0%	Zinc 86.2%
	Lead 70.2%	Lead 88.5%

The patent also makes a good suggestion that the silico-fluorides can be prepared by adding hydrofluoric acid to the ore pulp. This produces soluble silicofluorides of the bases in the pulp. The main value of a substitute for sulphuric acid would be for ores containing a great deal of calcium carbonate or other acid-consuming materials in the gangue.

CALCIUM SULPHATE

Copper sulphate has been added to ores containing colloidal gangue, although its success has been somewhat erratic. It was once used in one of the Broken Hill mills and its effect was that of an electrolyte. It is very sparingly soluble so that there can never be a high concentration of its ions in solution, and it is hence more or less equivalent to the tartrates in providing ions rather slowly so that supposedly the flocculation of the gangue slime will not intrain particles of the desired mineral.

SODIUM MANGANATE AND SODIUM CHROMATE

These are two oxidizers recommended for differential flotation of two flotative minerals. They seem to deaden one on the other of the flotative minerals so that it will not float. The exact mechanism of this deadening action is not known for while chromates will deaden galena particles in the presence of sphalerite, manganese compounds have the reverse effect. They are very efficient in this type of work but there is a widespread impression among metallurgical men that they are too expensive. To be sure, the market prices on the chemicals usually sold are rather high but high purity of these compounds is not essential. There is no apparent reason why they should not be made by fusing local manganese or chromium ores with sodium carbonate. Manganese ores are usually easily available in most zinc and lead districts although the chromium ores are harder to obtain. Mill managers who have considered only potassium permanganate of the usual high commercial purity might well give their attention to the more cheaply prepared and equally useful sodium manganate.

SULPHUR DIOXIDE, SODIUM SULPHITE, SODIUM THIOSULPHATE

These reagents are inhibitors of flotation, if used in sufficient amounts. If sulphur dioxide is applied to an ore pulp the first effect is one similar to that obtained when sulphuric acid is added to the pulp—an improvement in the flotation. However, if the sulphurous acid is allowed to act on the ore long enough to form sulphites the result will be non-selective flotation and the gangue will be floated with the desired mineral particles. The great use of such compounds has been found in differential flotation, the basic idea being to add just enough of one of these inhibitors to deaden the surfaces of one kind of flotative minerals while another group is only slightly affected and can still be floated. Mixtures of sphalerite, galena, pyrite and chalcopyrite or any two of them, usually need separation and in case they need to be finely ground to be liberated from each other mechanically differential flotation methods are in demand.

CHLORIDE OF LIME

Chloride of lime is said to be very good for differential flotation of sphalerite in the presence of pyrite.

SODIUM CYANIDE

In most cyanide mills which have tested their tailing by flotation it has been found that the cyanide left in the tailing is deleterious to flotation. E. J. Atchison has informed us that in some tests made by him with the ore of the Amparo Mining Company, of Mexico, this effect was noticed unless the amount of cyanide present was less than 0.007 per cent on the weight of the ore or 0.0018 per cent in the mill water, under which conditions improved flotation results were obtained over what could be done in water containing no cyanide.

At the mill of the Ohio Copper Company, Lark, Utah, mine water containing a rather high percentage of the sulphates of iron and similar impurities is used in the flotation and the addition of a small amount of cyanide has been found to greatly improve the flotation.

It is probable that in both these instances complex double cyanides are formed with the solutes in the mill water and it may even be that some of the most undesirable are precipitated by the cyanide. So far as we know very little has been done in the study of the cyanogen compounds for flotation.

CONCLUSION

The use of certain chemicals in the flotation concentration of ores has been described and theories of the action of these chemicals have been explained. The use of chemical addition agents in ore-pulps during flotation is only in its infancy, and as the process is better understood operators will make greater use of chemical addition agents which will allow them to obtain the highest economic results. The possibilities of such applications are almost unlimited and it is probably along lines of this kind that some of the great advances in ore flotation will be made.

Flotation of Chalcopyrite in Chalcopyrite-Pyrrhotite Ores of Southern Oregon*

BY WILL H. COGHILL

INTRODUCTION

In 1916 the Federal Bureau of Mines entered into a co-operative agreement with the Oregon Bureau of Mines and Geology for the purpose of investigating problems bearing on the treatment of low-grade and complex ores. The writer, as consulting metallurgist, was placed in charge of these investigations, and laboratory room for the necessary tests and experiments was provided at the Oregon Agricultural College, at Corvallis. One of the first problems taken up was the possibility of separating chalcopyrite from pyrrhotite and pyrite by flotation.

Chalcopyrite is the copper-bearing mineral at many places in southern Oregon; often it is intimately associated with pyrrhotite and pyrite. In places these two gangue minerals form as much as 75 per cent of the ore, so that the vein is almost wholly sulphides.

Gravitation methods of concentrating the copper-bearing mineral cannot be applied because the gangue sulphides have practically the same density as chalcopyrite. Magnetic separation does not seem practicable—assuming that the gangue sulphides can be made to respond naturally or by a preliminary treatment to an electromagnet—because fine grinding is required to liberate the mineral grains. The methods of concentration now in vogue are hand-sorting and jigging, which eliminate some of the siliceous gangue. An inspection of the smelter returns in the possession of mine operators gives the impression that the average grade of ore shipped runs 10 per cent copper.

The experiments on separating the chalcopyrite from the gangue by flotation have been carried through the preliminary laboratory stage with flattering results. As a mill is never considered complete and finished until the ore-body is exhausted and the mill has served its purpose, so in this and in other ore-testing experiments there are still undetermined factors. However, in order that those who are interested in the separation of sulphides by flotation may have the results of the laboratory work before them, this preliminary report is published by the Bureau of Mines.

TESTS AND GENERAL DISCUSSION

The tabulated data in Table I show the results of what might be called progress tests or those in which the results were similar to those of successful practice. Many random tests were made to find the nature of disturbing influences and how to meet them, but only a few of these are mentioned.

TABLE I—RESULTS OF PROGRESS TESTS

(Samples used weighed 1 to 16 pounds and carried 1.13 per cent to 3.2 per cent copper; ratio of concentration from 8 into 1 to 12 into 1.)

No.	Name of Mine	Through 200-Mesh, per Cent	Grade of Tailings: Per Cent Copper in Tailings	Grade of Tailings: Per Cent Copper in Tailings of Total Copper in Ore
1	Waldo	54.0	0.45	7.2
2	Waldo	74.6	0.70	20.7
3	Waldo	94.0	0.30	6.1
4	Waldo	92.0	0.50	13.0
5	Morrison	44.0	0.12	6.3
6	Morrison	97.7	0.12	5.0
7	Rowley	82.0	0.25	8.6
8	Rowley	82.2	0.20	6.2
9	Queen of Bronze	64.5	0.55	...
10	Queen of Bronze	64.5	0.30	23.4
11	Queen of Bronze	64.5	0.26	16.7
12	Queen of Bronze	64.5	0.23	8.1
13	Queen of Bronze	95.5	0.55	24.5
14	Queen of Bronze	94.5	0.50	20.3
15	Queen of Bronze	91.4	0.35	15.1
16	Queen of Bronze	92.0	0.90	29.2
17	Queen of Bronze	77.5	0.70	16.6
18	Queen of Bronze	99 0	0.60	16.1

All the samples were fresh and unoxidized except Nos. 16, 17 and 18. These three contained some malachite and azurite; this accounts for the tailings being higher grade than the average.

Several of the progress tests were made to conform to the tentative flow sheet (Fig. 1). The results of one

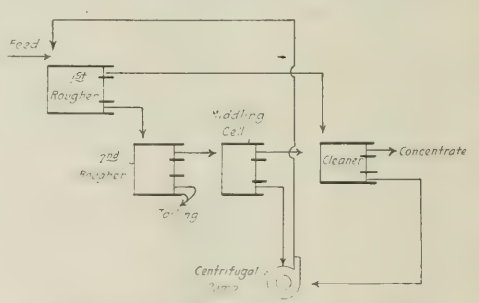

FIG. 1. TENTATIVE FLOW SHEET FOR CHALCOPYRITE-PYRRHOTITE ORES OF SOUTHERN OREGON.

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which was made in co-operation with D. C. Morris, representing the American Exploration Co. of Grants Pass, are given in Table 2. This sample was crushed excessively fine. It is likely that a fineness of 75 per cent through 200-mesh would have been satisfactory. Callow cells were used, but the Minerals Separation type of machines seemed to give equally good results.

TABLE II—PRODUCTS OF FLOTATION TEST OF QUEEN OF BRONZE ORE IN CALLOW CELLS

(Feed assayed 3.0 per cent Cu.; sample crushed to 99 per cent through 200-mesh; contained oxidized copper.)

No.	Products	Weight of Product, Grams	Percentage of Total Weight	Copper in Product, per Cent	Grams of Copper on 100-Gram Basis	Per Cent of Total Copper
54	Concentrate	450	6.0	28.3	1.70	58.5
63	Tailing from middling cell	925	12.3	3.3	.41	14.1
65	Tailing from cleaner	227	3.0	11.0	.33	11.3
61	Tailing	5940	78.7	0.6	.47	16.1
		7542*	100.0		2.91	100.0

*7542 grams—16.6 lb.

As the work was done with the intermittent type of machines, there were necessarily middling products—63 and 65 in Table II—that have to be disposed of by approximation, as shown below:

METHOD OF APPROXIMATING RESULTS

From Table II, the milled products would appear, on a 100-gram basis, to be about as follows:

Percentage of Recovery.—Nos. 63 and 65 containing 12.3+3.0=15.3 grams of pulp would produce a tailing running 1 per cent copper.

(*a*) Then 15.3×.01=.15 grams copper lost.

This loss added to that from No. 61 shows a total of .15+.47=.62 grams copper lost, or .62÷2.91=21.3 per cent of the total copper is lost. Hence the recovery is 78.7 per cent.

Ratio of Concentration.—These two middling products contain .41+.33=.74 grams copper.

By (*a*) .15 grams is lost.

(*b*) The recovery from them is, therefore, .74—.15=.59 grams copper.

(*c*) Assume that this .59 grams of copper is in a concentrate running 25 per cent copper. There would be, therefore, .59×4=2.36 grams of concentrate.

(*d*) The total concentrate would then amount to 6.0 (No. 54)+2.36(*c*)=8.36 grams concentrate.

This means a final concentration of 100 into 8.36 or 12 into 1.

Grade of Concentrate.—8.36 grams (*d*) concentrate contains:

1.70(No. 54)+.59(*b*)=2.29 grams of copper;

2.29÷8.36=27.4 per cent copper in concentrate.

COMMENT ON METHOD

This method of approximation applied to the tests from samples 1 to 15, inclusive (Table I), which show an extraction of 90 per cent with an equally high grade concentrate, except where, as shown by grab samples of the overflow, the test was stopped too soon. The reader should note in regard to the tests shown in Table II that only 15.3 per cent of the charge entered the closed circuit for retreatment. This quantity although small when compared with average practice is excessive for these ores; it was great in these tests because the tests were prolonged in the effort to float the oxidized copper. The freedom with which the fresh chalcopyrite floats is remarkable. At times there is also a striking play of brassy colors on the overflow.

COLOR NOT A TRUE INDICATOR OF GRADE OF FROTH

This reference to color introduces a fertile subject for scientific discussion but it must be treated briefly here. The first impression was that the color was a true indicator of the grade of the froth, but later work showed that it was not. Sometimes the Minerals Separation type of machine gave a richer looking froth than the Callow type, when analysis showed it to be of lower grade. When the pulps are of equal densities, the Minerals Separation machine gives, without fail, a brassier froth than the Callow. This seems natural because the Minerals Separation machine makes less froth where the bubbles have had more opportunity to gather the chalcopyrite. The burden of chalcopyrite is, therefore, heavier and more evident than in a Callow machine where the great number of bubbles—some of them doubtless barren—dart to the surface and form a voluminous froth. The heavy burden of non-wetted mineral carried by the froth stabilizes it by the "screw-back" effect that the author has discussed in a recent paper.[1]

The Callow froth showed a better color on the concave upward surface than on the convex, *i. e.*, in the depressions. Although it is true that the weight of the mineral grains should be considered as a factor in causing them to slip down the surface to the lowest point and thus increase the burden there, the reader should note also that the resultant of the molecular forces points in that direction. The non-wetted mineral particles (on the upper surface) would, therefore, be expected to slip down the "meniscus" while the tendency of molecular forces would be to pull the wetted mineral particles to the highest points, resulting in segregation. The relation of the component forces has been outlined in a paper in the Colorado School of Mines *Magazine*.[2]

GOLD RECOVERY

The ores assay about $2 a ton in gold. Hand-sorting a Queen of Bronze sample and assaying revealed that about 95 per cent of this gold is in the chalcopyrite. Unfortunately the flotation concentrate contains too small a proportion of the gold. It is likely that the gold is embedded in the cleavage planes of the chalcopyrite and is released on crushing. The gold in the tailings amalgamated freely in bottle-amalgamation tests, proving it to be in the metallic state.

Only one oil was tried. It was selected from a stock of twenty-two oils on account of its desirable physical properties. The surface tension effect of these oils had been determined and plotted by E. H. Miller of the Bureau of Mines, and the one used was found to give a steeper surface tension curve than any other oil in stock. This was desirable because it was thought that a froth with a slightly variable surface tension would, with the solids present, be sufficiently stable. Whether the other oils would have proved satisfactory was not determined but the oil mentioned gave excellent results. Its miscibility is an important characteristic.

Only once, and then by accident, was the ore ground

[1] Rickard, T. A., and Ralston, O. C., Flotation, p. 195 (1917).
[2] Coghill, Will. Natural Laws in Flotation, Colorado School of Mines *Magazine*, Vol. 7, 1917, p. 1.

in the presence of an insoluble oil. The insoluble oil acted as a collector on all the sulphides present and spoiled the differential separation sought. The overflow carried only 5 per cent copper whereas 30 per cent copper in the first overflow was desirable and expected when the pulp carries 2½ per cent.

As already stated, the oil used reduces surface tension. It seems strange, in view of all that has been written about surface tension, that there are no published data on absolute values of surface tension of mill solutions. In the course of these experiments several determinations were made by the drop-weight method. One determination gave: Surface tension of overflow 65.9 of underflow, 69.8. This result is in accord with tests made to prove absorption, as given in textbooks on colloid chemistry. The quantity of oil necessary is minute, one-tenth of a pound per ton of ore being ample. The oil was added to the charge in the cell, and the overflow could be drawn after an interval of a few seconds. Neutral water was used.

PRECAUTIONS TO BE OBSERVED IN USING PROCESS

The process is simple when two "Don'ts" are observed.

Don't grind in the presence of an insoluble oil; use it cautiously in any event.

Don't grind samples in a disk pulverizer, and if the use of a ball-mill instead of a pebble-mill is contemplated, make careful tests to see whether the iron surfaces of the balls have an injurious effect. This is especially interesting in connection with the statements of Zachert[3] and Gahl[4] showing that the use of iron balls has a beneficial effect.

In the experiments described in this paper no apparatus was available for determining the effect of grinding with iron balls in a ball-mill, but it was proved conclusively that, for the flow-sheet used, the use of the disk pulverizer is not only objectionable but should be avoided for either wet or dry crushing. The same conclusion applies to a "made-up" ore containing chalcopyrite. Two comparative runs were made. Each sample consisted of pulp that had been prepared for cyanide tests, and 30 grams of chalcopyrite. The copper mineral in one was prepared in the disk machine, in the other it was ground to the same degree of fineness in a porcelain mortar. Table III shows the relative floatability. The mineral prepared in the mortar overflowed much more freely and gave a higher grade product.

Table III—Results of Disk and Mortar Grinding

Prepared in	Grams—Overflow	Copper in Overflow	
		Per Cent	Grams
Disk	10	14.0	1.4
Mortar	24	16.2	3.9

These results show that the disk pulverizer should not be used until proved harmless.

Exports of Mineral Oils Show Big Increases.—More mineral oils were exported from the United States during the fiscal year 1917 than ever before, the total amounting to 2,749,438 gallons valued at $230,953,149, according to figures made public by the Bureau of Foreign and Domestic Commerce. This was an increase of approximately 300,000,000 gallons over 1916.

[3]Zachert, Victor, Beneficial Effect of Grinding with Steel Balls in Flotation: *Min. and Sci. Press*, Vol. 114, May 12, 1917, p. 663.
[4]Gahl, Rudolf, History of the Flotation Process as Inspiration, *Bull. Am. Inst. Min. Eng.*, No. 117, Sept., 1916, p. 1656.

Laboratory Methods* for Benzol-Recovery Plant Operation

By F. W. Sperr, Jr.
Chief Chemist, H. Koppers Co.

The importance of the benzol industry to the cause of National Defense has achieved general recognition during the last three eventful years. The recovery and rational utilization of as large amounts as possible of benzene and toluene, which are so important in the manufacture of explosives, must be considered a national necessity. There are two indispensable steps in securing the most efficient conservation of our benzol resources, namely:

1. The installation of the most efficient type of benzol-recovery plant wherever sufficient benzol is being produced to warrant recovery.

2. Careful control of the operation of each plant so as to reduce losses to a minimum.

The second step involves the use of correct laboratory methods for the testing and analysis of the various materials and products. The importance of this phase of the industry must be highly emphasized, and in view of this the writer has obtained the consent of the H. Koppers Company to publish some of the laboratory methods that it has found valuable. These cover all of the ordinary requirements of the benzol plant operator and chemist, for whose assistance, principally, the somewhat detailed descriptions have been written.

In studying the methods from an operating standpoint, it will be of assistance to the reader to review briefly the method of operation of the benzol-recovery plant. The Koppers system, which is the most generally used in America, is shown on the accompanying diagram, Plate A.

The gas is brought to the proper temperature in the cooler *a*, and then passes into the washer *c*, where it is treated with an absorbent oil which scrubs out all of the benzols. The enriched wash-oil is pumped from the scrubbers to heat exchangers *e* and *f*, which are heated by the benzol vapors and by the hot debenzolized wash-

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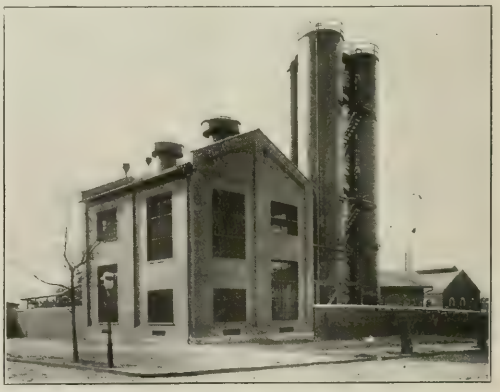


THE FIRST PLANT IN THE WORLD FOR THE RECOVERY OF TOLUENE FROM CARBURETTED WATER GAS

Built by the H. Koppers Company early in 1916. This plant has a capacity for recovering toluene from ten million cubic feet of gas per day

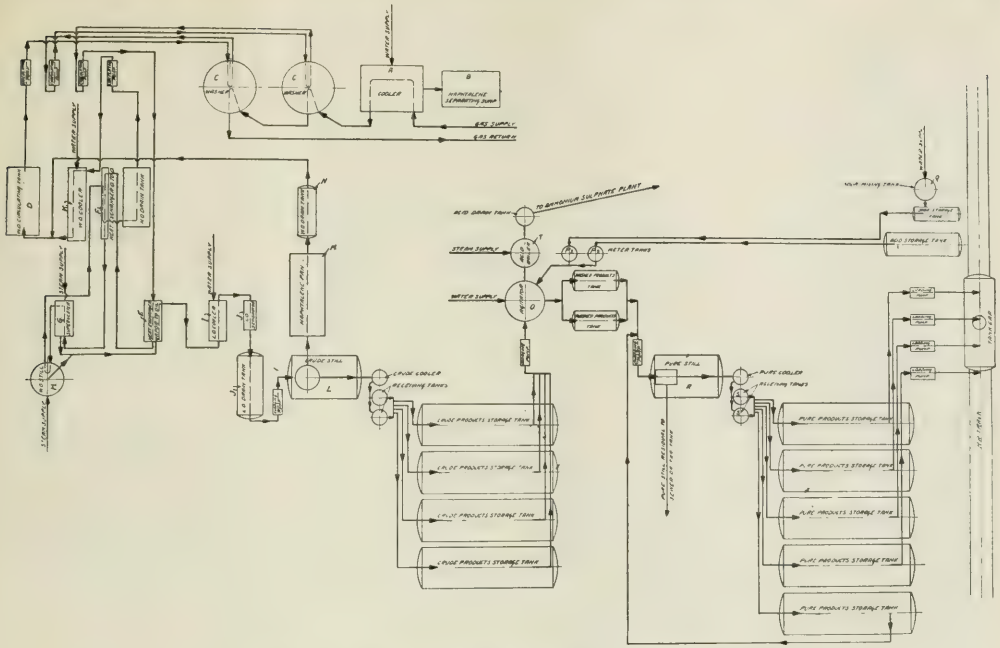


PLATE A. DIAGRAM OF KOPPERS SYSTEM OF BENZOL RECOVERY

oil respectively. It is then still further heated to the maximum temperature desired by means of live steam in the superheater *g*, from which it passes into the still *h*. In this still the benzols are entirely expelled in the form of vapor. This hot vapor gives up part of its heat to the incoming wash-oil in the heat exchanger *e*, and then is condensed and separated from water in cooler *i* and separator *j*. The hot wash-oil leaving the bottom of the still passes through heat exchanger *f*, where it gives up part of its heat to the incoming wash-oil, and then is finally cooled in water cooler *k*. The cool oil is delivered to circulating tank *d*, from which it is pumped back again over the scrubbers; thus completing the cycle. The light oil is distilled in crude still *l* and the various fractions are purified by treatment with acid and soda in agitator *o*, and rectification in the pure still *r*.

Practically every by-product coke plant in America is now equipped with benzol-recovery apparatus, but the total product does not satisfy the ever increasing demand. To augment the supply of the important benzols—particularly toluene—we still have recourse to the large quantities of water gas that are manufactured for domestic purposes throughout the country. The H. Koppers Company was the first to undertake the large scale recovery of benzol from water gas. Plants built by this company are now treating nearly 2,000,000,000 cu. ft. of gas per month, and are producing nearly 1,000,000 gal. of crude light oil per month. Additional plants, now under construction, will soon largely increase this rate of production. In most cases, the toluene, which is so important for military purposes, is the only important substance separated from the light oil; the other benzol homologues being returned to the gas to satisfy requirements for candlepower and calorific value.

The routine tests usually required in the operation of a benzol-recovery plant completely equipped for the production of pure benzene and toluene may be classified as follows:

A. Tests of Gas:
   1. Determination of light oil in gas entering scrubbers.
   2. Determination of light oil in gas leaving scrubbers.

B. Tests for Wash Oil Still Operation:
   1. Determination of light oil in benzolized wash-oil.
   2. Determination of light oil in debenzolized wash-oil.
   3. Tests of the light oil:
      a. Boiling point.
      b. Determination of wash-oil.

C. Tests for Crude Still Operation:
   1. Receiver tests; *i.e.*, boiling point tests made to control fractionation.
   2. Boiling point tests of fractions (crude benzol, crude toluol, etc.) and residues sampled from their respective storage tanks.

D. Tests for Agitator Operation:
   1. Distillation and acid tests of washed benzols.
   2. Tests for SO_2 in washed benzols.
   3. Specific gravity of regenerated sulphuric acid.

E. Tests for Pure Still Operation:
   1. Receiver tests; *i.e.*, boiling point tests made to control fractionation:
      a. Boiling point.
      b. Acid test.

2. Tests of pure products sampled from storage or running tanks or from shipments.
   a. Boiling point.
   b. Acid test.
   c. Specific gravity.
   d. Freezing point (occasional in case of benzene).
3. Boiling point tests of still residues.

F. Tests of Materials used in Operation:
1. Wash-oil:
   a. Specific gravity.
   b. Viscosity.
   c. Emulsification.
   d. Cold test.
   e. Distillation.
   f. Olefines.
2. Sulphuric acid—Specific gravity.
3. Soda—Na_2O.

Method for the Determination of Light Oil in Gas

APPARATUS

1½-in. steam-jacketed sampling pipe with valve (Fig. 1).
11 reagent bottles, 16-oz., narrow neck, with rubber stoppers.
1 wet gas test meter reading to 0.001 cu. ft. with the thermometer.
1 steam distilling apparatus, 1 gallon capacity.
2 Liebig condensers—15 inches.
1 separatory funnel—300 c.c.
1 special distilling flash—200 c.c.
1 measuring tube 50 c.c, graduated in 1/10th c.c.
1 thermometer—200 deg. C.
1 Hempel dephlegmating column (Fig. 2).
Burners, supports, and tubing, to complete apparatus as described below.

The method consists of three steps, viz.:
1. Extraction of the light oil with wash-oil.
2. Steam distillation of the benzolized wash-oil.
3. Dry distillation of the separated light oil.

The wash-oil must be a petroleum product corresponding to specifications that will be published later in this series of articles.

Referring to Fig. 1, *B* is a ½-in. sampling pipe inserted in the gas main (*A*). The end in the center of the main is bent in the direction of the flow of the gas. In case the gas contains much naphthalene, provision must be made to heat a portion of the sampling tube where it emerges from the gas main. This may be accomplished as shown in the figure by means of a steam jacket about 20 in. long and 2 in. in diameter. When the naphthalene is in large quantity, causing stoppage, it may be necessary to keep the first two or three bottles of the absorbing train immersed in warm water, and to wrap all connections with asbestos or flannel.

FIG. 1—ABSORPTION APPARATUS FOR LIGHT OIL IN GAS

The flow of the gas is controlled by means of the valve (*D*).. The ends of the rubber stoppers that would be exposed to the gas are covered with a little sodium silicate solution just previous to each test. If this precaution is not taken the rubber will absorb appreciable quantities of benzol.

Bottle No. 1 contains about 100 c.c. sodium hydroxide (1 part NaOH to two parts H_2O). Each of the other ten bottles contains about 150 c.c. wash-oil. Rubber tubing is used to connect up the train, but the ends of the glass tubes must be brought closely together so that as little as possible of the rubber may be exposed to the gas. The wash oil must be maintained at a temperature not to exceed 20 deg. C. throughout the test. If necessary, the bottles must be placed in a trough through which cold water is circulated, or else the water may be kept sufficiently cold by adding pieces of ice from time to time.

The gas passing from the train is measured by means of the wet test meter, which must be provided with a thermometer, so that readings may be taken for temperature correction. As a rule this type of meter is not suitable for measuring over 100 cu. ft. of gas, and when gas containing very small amounts of light oil is tested, it is advisable to use a somewhat less sensitive meter of larger capacity. The water in the meter should in all cases be saturated with the gas, and should be at the proper level.

Having connected up the train as shown, heat the sampling tube and let the gas blow out of the valve *D* until the tube is well cleared. Then connect bottle No. 1 with the valve, turn on the gas and inspect the train carefully for leaks. It is usually necessary to have the stoppers securely wired down. Now adjust the rate of flow. Note and record the meter temperature and the barometric pressure every hour during the test and adjust the rate of flow as often as may be necessary.

The amount of gas to be scrubbed depends on its light-oil content. When testing gas before the benzol scrubbers it is best to regulate the gas volume so that not more than 35 or less than 20 c.c. of light oil will be obtained. In the case of debenzolized gas sampled after passing the scrubbers, it is necessary to take about 100 cu. ft. in 24 hours.

When the required volume of gas has passed through the apparatus, close the valve *D* and disconnect the individual bottles of the train. Pour the wash oil into the copper still of the steam distillation apparatus and rinse each bottle and dip tube with a little fresh wash oil, pouring the rinsings also into the same still. The train may now be filled and connected up for the next test.

STEAM DISTILLATION

Part of the apparatus for this process is shown in Fig. 2. *A* is a copper still of one gallon capacity fitted with a screw cap through which pass the inlet tube for the steam, the exit tube to the dephlegmating column, and the thermometer *C*. The thermometer blub must dip below the surface of the wash oil and the 180 deg. mark must be visible outside the still. The dephlegmating column is of brass, and is preferably wrapped in asbestos to prevent undue condensation. Dimensions for this are given on the drawing; the bead column is about six inches long. The inlet tube *B* is connected with a suitable source of dry steam by means of a short piece of rubber tubing. In default of a regular supply

of boiler steam an ordinary one-gallon can, fitted with the usual rubber stopper, safety tube and exit tube, and heated by means of a large burner, makes a very satisfactory steam generator. The neck of the dephlegmating column, which has been bent over, is connected with a 15-in. Liebig condenser (*E*). The lower end of the condenser tube passes into a 300-c.c. separatory funnel. Corks must be used for all connections that will be exposed to light-oil vapors. The separatory funnel is wrapped with a cotton cloth and the outlet tube of the condenser is arranged so that cold water will run over this cloth and keep it thoroughly drenched. A small piece of cotton wool is placed in the mouth of the separatory funnel and around the end of the condenser to prevent currents of air causing undue loss. The separatory funnel is graduated by putting in 25 c.c. of water, marking the level, and then adding 100 c.c. more and marking again.

Place a burner under the copper still and heat until the thermometer shows a temperature of 180 deg. Now turn on the steam and adjust the burner so that the temperature does not exceed 180 deg. nor fall below 170 deg. Water and oil will collect in the separatory funnel. When the water level reaches the 125-c.c. mark, run out 100 c.c. Repeat this until 500 c.c. have been run out, at which point the distillation may be considered complete Shut off the steam and gas and remove the separatory funnel from its support. Run the remainder of the water out carefully. Add to the contents of the funnel 10 to 20 c.c. of a saturated solution of calcium chloride and shake well. Let stand until clear and then run off the calcium chloride solution. Wipe the outlet tube of the funnel dry with a little cotton.

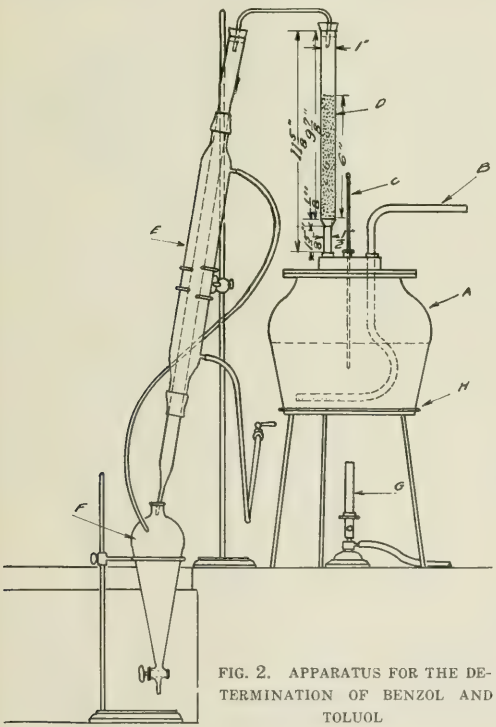


FIG. 2. APPARATUS FOR THE DETERMINATION OF BENZOL AND TOLUOL

A—Copper Kettle.
B—Steam Inlet.
C—Thermometer.
D—Brass Dephlegmating Column Filled.
E—15-in. Condenser (with 8-m.m Glass Beads)
F—Separatory Funnel 300 c.c.
G—Bunsen Burner.
H—Asbestos Board.

DRY DISTILLATION

Run the dried oil from the funnel into the special distilling flask (Fig. 3) fitted with a cork stopper and thermometer, with a 5½-in. column of 6-mm. glass beads, and connected with a 15-in. Liebig condenser. The condenser is supported vertically and a 50-c.c. measuring tube is placed so as to catch the distillate. Heat the contents of the distilling flask with a small flame, until the vapor temperature reaches 200 deg. C. Allow the condenser to drain a few minutes, then read the volume of oil distilled, correcting for water if present.

CALCULATIONS

Average the barometric pressures and the meter temperatures for the period of the test. Correct the observed gas volume to 760 mm. pressure and 15 deg. C. with the aid of the usual formulæ or tables.

A = corrected gas volume.
B = cubic centimeters light oil obtained.

Then: Gallons light oil per 1000 cu. ft. gas = $\frac{0.264 \times B}{A}$

It will be noted that the result is not expressed as the light-oil content of the original gas, but refers to the gas as measured after the process of extraction. This is in accordance with operating conditions, since as a rule the gas is metered after passing the benzol scrubbers. It is hardly worth while making correction for CO_2 and H_2S removed by the sodium hydroxide in the test apparatus except in cases where these two constituents may be unusually high.

NOTES

(1) The number of bottles in the absorbing train has been worked out by experiment and cannot be reduced without risk of a loss of light oil.

(2) An automatic siphon arrangement may be used for running off the water from the steam distillation, dispensing with watching the separatory funnel. The volume of water in this case should not be reduced much below 75 c.c.

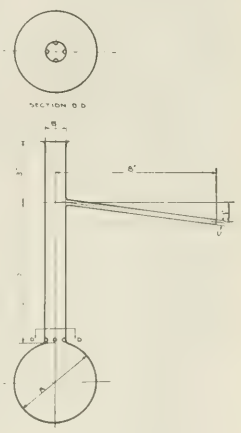


FIG. 3. FLASK

The Analysis of Light Oil

The following method was devised for the purpose of estimating the percentage of benzene, toluene, and solvent naphtha in the light oil obtained in connection with the previously described method for

the Determination of Light Oil in Gas (see first page).

Ordinarily the light oil produced from two or three tests may be combined for each analysis. The method has been employed for some time and has given good results for the usual run of light-oil samples, which generally contain at least 50 per cent benzene, and not over 30 per cent toluene. The accuracy of the method is much less for light oil containing less benzene or more toluene, but such material is not so often encountered. If necessary, the simple expedient can be adopted of adding sufficient pure benzene to bring the composition of the sample within the proper limits. Such check determinations as we have made on samples of known composition show that, with careful attention to details, the amounts of benzene, toluene and solvent naphtha can be determined, with an error in each case amounting to about 1 per cent of the total light oil, which is satisfacory enough for ordinary purposes.

PURIFICATION OF THE LIGHT OIL

A sufficient quantity of the light oil is measured from a burette and distilled to 200 deg. C., using a flask fitted with a Hempel column, containing 5 or 6 in. of glass beads. In the testing of samples produced in connection with the determination of light oil in gases this preliminary distillation is made as part of such determination, and need not be repeated. It may be omitted in other cases at the discretion of the chemist. The distillate is caught in a suitable burette and measured. A quantity—preferably about 100 c.c., and in any case not less than 50 c.c.—is drawn off into a slender 300-c.c. separatory funnel, and treated with 6 per cent of its volume of concentrated sulphuric acid (sp. gr. 1.84). This treatment is in two stages.

First, two-thirds of the sulphuric acid is added, then one-third. After each addition of the acid the mixture is shaken about five minutes, allowed to stand until separation is complete (about 15 minutes) and the sludge drawn off. The light oil is now washed with lukewarm water (about 40 deg. C.) and this is carefully drawn off. Then 5 per cent of its volume of sodium hydroxide solution (sp.gr. 1.107) is added; the mixture shaken for 5 minutes, allowed to settle about 15 minutes or until clear, and the alkali solution carefully drawn off. Finally the oil is washed with warm water (about 40 deg. C.) and this is drawn off.

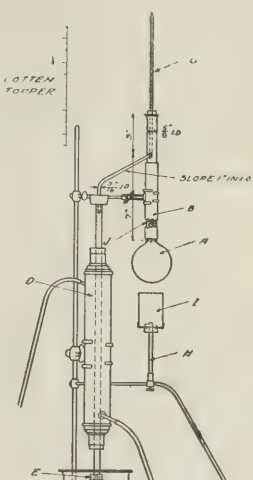


FIG. 4. LIGHT-OIL STILL FOR FRACTIONATING

A—200 c.c. Distilling Flask.
B—Asbestos Wrapping.
C—200 c.c. Ther. Grad. 1°.
D—Condenser—15-in.
E—Slit in Cork Filled with Cotton
F—120 c.c. Erlenmeyer GG. Stopper.
G—Ice Water.
H—Bunsen Burner.
I—Flame Protector.
J—5½-in. G. M. M. Glass Beads.

Most of the water is removed by washing with 15 to 20 c.c. of saturated calcium chloride solution. After this has been drawn off a little solid $CaCl_2$ is added and the mixture allowed to stand over night. The light oil is then decanted back into the burette and measured. The difference in volume gives an indication of the practical loss to be expected by sulphuric acid purification on a large scale. The specific gravity of the washed light-oil is determined (at 15 deg. C.), using a pyknometer or Westphal balance.

METHOD OF FRACTIONATION

The distilling apparatus is shown in Fig. 4. The thermometer used is an ordinary thermometer graduated in single degrees, which has been checked against the boiling point of water. Correction for barometric pressure and exposed thread has not been found necessary owing to the relatively small amount distilling in the intermediate stages. The diameter of the thermometer, however, should be less than half the diameter of the still head. The thermometer is so placed that the top of the bulb is level with the side neck of the distilling flask, and the top of the bead column must be at least ½ in. from the bottom of the bulb. Three 120-c.c. glass-stoppered Erlenmeyer flasks, numbers I, II and III, are used for catching the distillates. Weigh the flasks empty and weigh the sample in flask II.

Transfer the weighed sample to the distilling flask; distill into flask II with a carefully regulated and protected flame, not faster than one drop per second. At the temperature of 130 deg. C. stop the distillation and allow the condenser to drain well. Replace flask II with flask III, resume the distillation, stopping when the temperature of 200 deg. C. is reached; then weigh the fraction in flask II (designate as fraction "A"), and the fraction in flask III (designate as fraction "B").

Place fraction "A," contained in flask II, in a similar distilling flask and distil to 95 deg. C., catching the distillate in flask I, allow the condenser to drain, replace flask I with flask II, and distil to 120 deg. C. Occasionally the flask will go dry before 120 deg. C. is reached. In such event allow the flask to cool, so that vaporization will not take place when the stopper is removed, and add a small portion of fraction "B" (3 c.c. has been found sufficient in all cases to drive over all the lighter oils), and then resume the distillation. All of this process of distillation must be performed slowly, especially when running off the portion between 95 deg. and 120 deg C.; about 1 drop every 2 seconds is the correct rate.

Now weigh the fraction in flask I (designated as fraction "C") and the fraction in flask II (designated as fraction "D"). Put fraction "C" into a similar distilling flask and re-distil to 95 deg. C., catching the distillate in the same flask, No. I. If difficulty is found in reaching this temperature, owing to the flask going dry, let the flask cool and add a small portion (3 c.c. is sufficient) of fraction "D." This final distillation must be made very slowly, starting with one drop in two seconds and finishing with one drop in four seconds. Finally weigh flask I. Designate its contents as fraction "E."

The weighing flasks are not cleaned between distilla-

tions. The distilling flasks and condenser must, however, be clean and dry for each new fractionation.

METHOD OF CALCULATION

Call last fraction to 95 deg. "E"
Call first fraction to 95 deg. "C"
Call fraction 95 to 120 deg. "D"
Call fraction to 130 deg. "A"
Call fraction 130 to 200 deg. "B"

"E" is equivalent to the weight of the true benzene content.

"D" + ("C"—"E") is equivalent to the weight of the true toluene content.

"B" + ("A"—"C"—"D") is equivalent to the weight of the true solvent naphtha content.

In order to figure percentages by volume, take the specific gravity at 15 deg. C. of fraction "E" for the benzene, of fraction "D" for the toluene, and of fraction "B" for the solvent naphtha, and make the necessary calculations to percentages by volume of the original light oil. On account of the small size of the distillates, the determination of specific gravity will usually have to be made in each case with a carefully calibrated pyknometer. If possible use a 10 c.c. pyknometer, fitted with a thermometer.[1] These materials have large coefficients of expansion, which necessitates careful and rapid weighing.

CORRECTION FOR PARAFFIN HYDROCARBONS

In some cases such substances may be present, and are indicated by the low specific gravity of the fractions. The method for calculating the percentage of non-aromatic hydrocarbons is based on Dr. Rittman's suggestion.[2] The following figures are based for the specific gravities[3] in question.

Specific Gravity at 15 Deg. C. on	Aromatics	Non-aromatics
Fraction "E"	.885	.720
Fraction "D"	.872	.730
Fraction "B"	.869	.760

The specific gravity of the fractions have been determined,

Let X = per cent aromatics of any fraction of original light oil.
Let Y = per cent non-aromatic of any fraction of original light oil.
Let G = sp. gr. determined.
Let A = sp. gr. aromatic fraction when pure.
Let N = sp. gr. non-aromatic constitutents.
Let P = per cent of original light oil of fraction under consideration.

$$X = \left(\frac{G-N}{A-N}\right) X\ P$$

$$Y = \left(\frac{A-G}{A-N}\right) X\ P$$

It is evident that the foregoing method of estimation of benzene, toluene, and solvent naphtha is a purely arbitrary one, and it may be open to some criticism on this account, but a considerable amount of experience with it has shown it to give satisfactory results, both by comparison with other methods and by tests on artificial mixtures, containing known quantities of the materials in question.

Table I shows the results of estimations on samples made up with known quantities of benzene, toluene and solvent naphtha.

TABLE I

		Actual Compos.tion of Mixtures			Estimated by Method		
Test	Sample Taken, c.c.	Benz., %	Tol., %	Solvent Naphtha, %	Benz., Lb.	Tol., %	Sol. Nap. and Loss (by Diff.) %
1	99.40	50.0	25.0	25.0	49.85	25.12	25.03
2	88.06	67.5	17.5	15.0	66.58	17.63	15.79
3	57.42	70.0	20.0	10.0	69.37	19.59	11.08
4	98.98	75.0	15.0	10.0	74.43	14.41	10.86
5	96.86	80.0	10.0	10.0	80.04	9.25	10.71
6	63.25	45.0	40.0	15.0	41.0	43.69	15.31

Test 6 is illustrative of several experiments that we have made which show that the method is not applicable to mixtures containing less than 50 per cent. of benzene. In cases of such mixtures, if a higher degree of accuracy is necessary, the fractions obtained from the preliminary distillation are mixed together and enough pure benzene is added to bring the composition of the sample within the proper limits.

In Table II we show the results of distilling samples at a too rapid rate. In test 1 the last fractionation was run at the rate of one drop per second, causing the separation of benzene to be inefficient. Test 2 was run rapidly throughout all the distillations.

TABLE II

		Actual Compos.tion of Mixtures			Estimated by Method		
Test	Sample Taken, c.c.	Benz., %	Tol., %	Solvent Naphtha, %	Benz., Lb.	Tol., %	Sol. Nap. and Loss (by Diff.) %
1	99.40	65.0	20.0	15.0	65.40	18.92	15.68
2	95.83	70.0	15.0	15.0	73.92	13.13	12.95

Table III shows results of estimations made by this method compared with analyses of light-oil samples made according to the method of Wilson and Roberts.[4]

TABLE III

Estimated by Method Given				Estimated by Method of Wilson and Roberts		
% Benzol	% Toluol	% Solvent	Test	% Benzol	% Toluol	% Solvent
48.0	20.2	11.0	1	48.9	19 8	12.7
40.0	15.6	...	2	41.4	15.5	6 2
59.1	16.1	11.2	3	60.0	15 3	9 0
44.1	15.9	8.5	4	45.8	15.2	8.2
33.0	30.2	11.7	5	36.0	28.0	11.4

Test 5 shows results obtained from an oil containing too high a percentage of toluene for efficient fractionation by the method given. The benzene content should have been increased by the addition of a known quantity of C. P. benzene, but this was not done on this test.

APPROXIMATE ESTIMATION FROM THE BOILING-POINT TEST

It is interesting to note that a quick approximate estimation of the relative proportions of benzene, toluene and solvent naphtha in light oils of ordinary composition may be made directly from the results of the usual "boiling-point tests." The results are of considerable value to the practical benzol-plant operator. The method of making this test will be described in a succeeding issue.

The benzene is taken as the average of the amounts distilling at 95 deg. and 100 deg. C.

The toluene is taken as the amount distilled between 100 deg. and 120 deg. C.

Solvent naphtha is taken as 2/3 of the amount dis-

[1] Or use the Drushel pyknometer (U. S. Bureau of Mines, Bulletin 125, p. 27).
[2] Met. & Chem. Eng., 1915, Vol. XIII, p. 682.
[3] Some light oils contain carbon disulphide, the high specific gravity of which may completely mask the presence of any paraffins in the benzol fraction. In such cases the amount of carbon disulphide must be determined (V. Lunge, Coal Tar and Ammonia, 5th ed., p. 982) and a suitable correction applied.
[4] Journ. Gas Lighting, May 2, 1916

tilling between 120 deg. and 180 deg. C. on unwashed materials, and as the amount distilled between 120° and 180° C. on washed materials.

In the case of light oils containing much over 60 per cent benzene, the per cent of toluene as estimated by this method will be considerably too low. When samples contain much over 20 per cent toluene the per cent toluene as estimated by the method will be considered too high (See Table V.) We have found it to hold fairly good when light oils contain from 45 per cent to 60 per cent benzene, and from 10 per cent to 20 per cent toluene.

Thus suppose we have a light-oil sample which gives the following results by the "boiling-point test:"

Temperature	% Total Light Oil Distilling
95 deg.	54
100 deg.	60
120 dge.	78
180 deg.	90

Then the per cent of benzene is the average of 54 and 60 = 57 per cent.

The percentage of toluene is 78 — 60 = 18 per cent.

The percentage of solvent naphtha is 90 — 78 = 12 per cent.

TABLE IV

Results of tests of known mixtures containing correct proportions of benzol, toluene and solvent, for estimation by boiling-point method.

Made Up from Pure Materials					Estimated by "boiling points"		
No.	% Ben.	% Tol.	% Sol.	% Petroleum Wash Oil	% Ben.	% Tol.	% Sol.
1	60	10	10	20	57	9	8
2	55	20	15	10	52	17	14
3	50	20	15	15	46.5	17	13
4	45	15	15	25	44.5	14	14

TABLE V.

Results of tests of known mixtures containing incorrect proportions of benzene, toluene and solvent for estimation by "boiling-point" method:

Made Up from Pure Materials					Estimated by "boiling points"		
No.	% Ben.	% Tol.	% Sol.	% Petroleum Wash Oil	% Ben.	% Tol.	% Sol.
1	70	15	10	5	71	9	8
2	30	50	20	..	9	66	17
3	20	60	20	..	0.5	83.5	16

TABLE VI

Comparison with fractionations, actual coke-oven light oils used

	Fractionated by Method of Wilson and Roberts			Estimated by "boiling points"		
No	% Benzene	% Toluene	% Solvent	% Benzene	% Toluene	% Solvent
1	47.5	15.7	8.9	48	14	9
2	47.0	14.0	6.0	46	14	9
3	46.3	13.8	6.0	48	13	9
4	44.8	15.3	7.6	45.5	14	9
5	41.4	15.5	..	40.5	14	10

It will be seen from Table IV that the percentage of light-oil constituents as estimated by the "boiling-point" test runs somewhat lower than the true values. However, on an unwashed coke-oven light oil this test will give values that check the real composition somewhat more closely (cf. Table VI). But even then about 1 per cent should be added to the toluol as determined.

Other methods for the analysis of light oil will be briefly abstracted for the sake of convenience. We have used all of these methods and found them to give good results when proper care is exercised in carrying out the distillations, but they all have their limitations in that they require comparatively large samples.

Hugh W. James, A. R. C. Sc. (*Jour. Soc. Chem. Ind.*, Vol. 35 p. 236, and *Jour. Gas Lighting*, Vol. 133 p. 531). The Determination of Toluene with a Note on the Application of the Method to Benzene and Xylene.

James distils 250 cc. of the oil to 140 deg. C. and through a six-bulb LeBal-Henninger column (other efficient columns may be used). The distillate is then distilled catching six fractions viz: to 90 deg. C., 90 to 100 deg. C., 100 to 109 deg. C., 109 to 112 deg. C., 112 to 120 deg. C., and residue at 120 deg. C. All of these fractions except the first and last are redistilled using a column as before. All that distils below 110.6 deg. is placed with the first fraction, and all above that with the last. This gives essentially a mixture of benzene and toluene in the first case, and of toluene and xylenes in the second. A boiling-point determination of each of the two fractions is then made and the percentage of toluene estimated from tables given. Figures are given showing the percentage of toluene in artificial mixtures as compared with the percentage estimated by method. On the whole very good results were obtained, but this method would not be so applicable to quantities as small as, say 50 cc.

Dyke Wilson and Ivan Roberts (*Gas Record*, March, 1916, and *Jour. Gas Lighting*, May 2, 1916). Determining Benzene, Toluene and Solvent Naphtha in Light Oils.

Approximately two liters of oil are used in this method. The oil is first purified by washing with sulphuric acid, then soda, and the product distilled with steam. This purified oil is placed in the still. The still is provided with a 40-in. Hempel column filled with glass balls for thirty-six inches. Attached to the top of the Hempel column is an efficiency vertical reflux condenser. By adjusting the temperature of the bath of the reflux, any degree of dephlegmation desired may be attained. Benzene is taken as the amount distilling to 81 deg. C. plus benzene in the intermediates. Toluene is taken as the amount distilling between 109 deg. and 111.5 deg. C. plus toluene in the intermediates. Percentages in the intermediates are estimated from boiling determinations in a side-neck flask, and comparison with tables. Solvent naphtha is taken as the difference between the amount of washed oil charged and the benzene and toluene as determined, less any distillation losses. Temperatures are measured by an accurate thermometer graduated in fifths of degrees inserted vertically in the top of the column above the reflux. The advantages of this method are that it gives large volumes of pure materials, only about 4 per cent of the total washed oil being in the form of intermediates.

Gustav Egloff (Met. and Chem. Eng., Vol. 16, No. 5, p. 259). The Analysis of Light Oils.

Egloff uses a large sample (approximately two liters). This is placed in a copper still of about four liters capacity. The column is about eight feet in length, made up of six sections of ¾-in. iron pipe one foot each in length with a top section eighteen inches in length. Sections are connected by means of sleeves. Between adjacent sections there is a 30-mesh iron gauze used as a diaphragm to support an 8-inch column of 2-in. glass rods of ⅛-in. diameter. Above each section of glass rods a ¼-in. iron pipe is screwed into the column which in turn is screwed into a ¼-in. main running down the outside of the column. This main at the lower end passes into the still, the lower end being just above the bottom, forming a seal when the light oil is charged. This small pipe then acts as a reflux for each of the sections. A thermometer is placed in the top of the column.

Distillation is conducted at a rate of two drops per second. The amount distilling to 95 deg. C. is taken as benzene, the amount from 95 deg. to 125 deg. C. as toluene, and the amount from 125 to 165 deg. C. as the solvent naphtha present in the starting mixtures. Various tables are given with a drawing of the still. The tables show the efficiency of the fractionation made and the accuracy which can be expected.

Egloff purifies the oil before fractionation by washing with sulphuric acid and soda, and then steaming with live steam to 180 deg. C. This oil distillate is dried and placed in the still for fractionation. Paraffins are estimated from the gravity of the fractions obtained.

Rittman (*Met. and Chem. Eng.*, 1915, p. 682) has described a method for the determination of benzol in light oil mixtures by nitration.

Method for the Determination of Wash Oil in Light Oil

Take a one liter sample of light oil (noting the temperature at which it is measured) and place in steam still of about one gallon capacity. After making sure that all joints and connections are tight, dry-distill to 120 deg. C. Then introduce steam, keeping the temperature between 120 deg. and 130 deg. Distil until 400 cc. of water have passed over. The apparatus is arranged as shown in Fig. 2, except that a one-liter separatory funnel is used. It is well to place an asbestos guard or shield between the separatory funnel and the flame, reducing the danger of fire. After distillation, the light-oil distillate is brought to the same temperature as the sample as first measured, and its volume is determined by means of a graduate. The volume of the oil left in the still is also measured. This volume added to that of the distillate should equal 1000 cc. if the still is carefully drained. The discrepancy should not exceed 5 cc. This residual oil is now cooled to 15 deg. C. and naphthalene filtered off by suction, drying as well as possible, and the loss in volume of the oil noted.

A fresh sample of wash-oil of the same type used in scrubbing the gas for light oil is taken for a blank.

Take 1000 cc. of this for a sample. Distil at 120-130 deg. C. in the same apparatus until 400 cc. water has passed over (as in the light oil distillation). Measure the volume of distillate, and calculate the amount of residue by difference.

CALCULATIONS

Let A = per cent oil residue (corrected for naphthalene) from first distillation.

Let B = per cent oil residue from blank (second) distillation.

$$\text{Then: Per cent wash oil in sample} = \frac{A \times 100}{B}$$

The **Society for Electrical Development** has recently issued two very interesting and instructive booklets on "Industrial Heating as a Central Station Load." Part One deals with electric furnaces as used in steel making and takes up the classification, operation and regulation of the principal furnaces. Other applications are also discussed. Part Two deals with welding apparatus, japanning ovens and similar work. Dwight D. Miller, whose paper on Non-Ferrous Metal Melting will be found elsewhere in this issue, is at the head of the engineering department. The Society's headquarters are in the United Engineering Societies Building, 29 West Thirty-ninth Street, New York.

Synopsis of Recent Metallurgical and Chemical Literature

Flotation

Cascade Flotation.—In the August, 1917, issue of the *Mining Magazine*, a description is given of the cascade flotation system developed by Messrs. Seale and Shellshear at the Junction North Mine, Broken Hill. It is claimed that the power required by the process is very small. The principle adopted by Messrs. Seale and Shellshear is that of the cascade; that is to say, the stream of pulp is caused to fall into water, the incoming stream entrapping air, which is subsequently released, and on rising acts as the buoying agent. This method of catching and compressing air by falling water is sufficiently well known, for it has been applied for the purpose of supplying compressed air to mines, a characteristic case being that introduced several years ago at Cobalt, Ontario. The cascade system has been applied recently for flotation purposes in America, particularly in the Crowfoot and Wilfley methods. Minerals Separation, the Sulphide Corporation and the Zinc Corporation have severally improved the Seale and Shellshear process. It is understood that Minerals Separation, the controller of the patents, has sent a representative to America to explain the process and experiment on its application to copper ore. No information is at hand relating to the construction of the plant actually employed. British Patent 10,666 of 1915, granted to Messrs Seale and Shellshear, describes the process. According to this patent the pulp is fed to a mixing box *B*, open at the top, from which it passes downward to a separating box *A*, also open at the top, through a pipe B^1, which delivers the pulp below the surface of the water in *A*. The baffle A^1 is

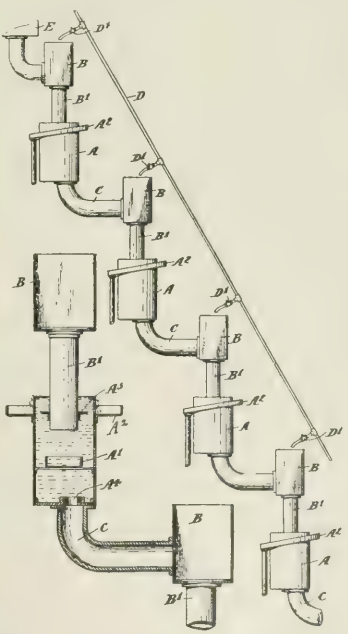


FIG. 1—DIAGRAM OF THE SEALE-SHELLSHEAR CASCADE FLOTATION PROCESS

placed in the box *A* so that the downward current of pulp and air shall be broken. The liberated air carries some of the sulphides upward, and after passing the baffle A^3 they are discharged into the annular launder A^2. The unaffected pulp passes through the orifice A^4 and the pipe *C* to the next mixing box *B*. The flow of the pulp through the pipe *C* causes a vigorous agitation. Additional water is introduced at the head of each successive mixing tank to compensate for that removed with the concentrate. The process has proved extremely successful at the Junction North, Central, and South Blocks mines. The details of construction of the actual plants are of course only suggested by the drawings in the patent specification. In practice the process is applied to the preferential separation of galena and blende. At the Central mine, half of the agitation plant has been laid by, in favor of the new process. According to the new method at the Central, the mine ore is first jigged for the removal of as much galena as possible, and the tailing, after regrinding, is sent direct, without any tabling, to the Seale-Shellshear plant. The oiling medium is added before the pulp goes to the flotation apparatus. The lead is removed in the first few separation boxes. Subsequently acid is added, and the blende is thereby floated.

Recent Developments in Germany

Chemical Developments. — *The Chemical Trade Journal and Chemical Engineer*, Sept. 22, 1917, publishes a review of recent chemical developments in Germany, taken from the *Neue Zürcher Zeitung*. Systematic investigations into the properties of coal have been carried on by the "Kaiser Wilhelm Institute für Kohlenforschung," and have yielded important industrial results. The treatment of coal with liquid sulphurous acid at ordinary temperatures has produced viscous, golden-yellow mineral oils, the amount produced being 5 kg. per metric ton. A process has also been elaborated by which through heating naphthaline under pressure in the presence of aluminium chloride, an oil is produced which can be used for illuminating purposes in the same manner as petroleum. Finally, by treating with ozone, it has been found possible to alter the carbon compounds in coal to compounds soluble in water, the chemical importance of which cannot at present be estimated.

The utilization of lignite has been greatly extended. In the first place it is being used extensively as a fuel in the industrial establishments which have recently sprung up in the Central German lignite fields, especially in the neighborhood of Bitterfeld and Halle a/S, where the German air-nitrate factories are situated. A process has been discovered by which twice the usual amount of ozokerite can be obtained from lignite, and the gas is being more extensively used for heating and smelting purposes.

In the field of the exploitation of nitrates directly from air a new process has been discovered, which works with quadruple air velocity through the reaction space and produces a result about 80 per cent higher than could be obtained before.

In the metal industry further progress has been made with the production of substitutes for copper, brass and bronze, especial mention being made of the different zinc and lead alloys, and of the increasing importance of aluminium.

Recently there have been new developments in ore smelting. With copper schists the metallurgical possibility of going as low as 0.7 per cent has been shown, whereas formerly the average lower limit was 2.5 per cent. Operations have been commenced upon large deposits of sandstone containing white lead. Successful experiments have been made in obtaining aluminium from clay, which will, it is claimed, make Germany independent of foreign bauxite in future. With nickel ores the workable limit has been reduced from 2.5 to 1.5 per cent. A process has also been discovered for obtaining nickel and cobalt from pit waters containing these substances.

In the German rubber industry the situation is said to have been eased by the progress made in rubber regeneration. The idea of exploiting German caoutchouc plants has been given up.

Tendency Toward Combines.—The *Neue Zürcher Zeitung*, according to the *Chemical Trade Journal and Chemical Engineer*, follows up its review of the progress made in industrial discoveries and processes in Germany during the war with a review of the progress accomplished in the field of economic organization in that country in the same period. The chief characteristic of the third year of war has, it is said, been the tendency toward compulsory and voluntary syndication of industrial concerns. Compulsory syndication has been demanded by the Government to secure economy in view of the scarcity of material and the shortage of labor; while voluntary syndication has been suggested and carried out by the parties interested by way of preparation for the prospective economic war, and in order to facilitate the return of peace conditions in the economic sphere, though in some cases this action has been in response to suggestions and hints on the part of the Government.

The great union in the chemical industry has been voluntary. This combine, which is for a period of fifty years, is primarily of a defensive nature. The constituent works retain complete independence and freedom of action, but profits will be pooled, all manufacturing experiences exchanged, and all products produced in at least two places. This arrangement, it is hoped, will do much to further the exploitation of new discoveries and to promote technical progress, with the result that the position of the German chemical industry in the world market will be strengthened.

Agreements with the same object have recently been made between the dyeing and explosives groups of industries. Details of the compact have not yet been made public. It is only known that an agreement has been made concerning the peace-time production and the sale of such articles as have always been produced by both groups. The explosives group consists of a combination of the Dynamite Trust and the powder group, which before the war were accustomed to divide profits according to a definite scale.

Since the outbreak of the war the largest German explosives factory, the Dynamit A. G. Nobel, in Hamburg, has been the center of German dynamite interests. An examination of the list of firms combining to form the German explosives trust and the powder trust, with those forming the aniline combine, shows that the German chemical industry is closely united.

In addition to the combines properly so-called, there have been numerous amalgamations and fusions of indi-

vidual concerns, which are further evidence of the general tendency toward the development of large organizations in German economic life. Numerous individual men of business are retiring into private life, their places being taken, as a rule, by large companies and combines. This concentration has been further promoted by measures taken or proposed within the States, such as the proposal to tax turnover. Were such a proposal carried into effect, it would probably give a great advantage to the large enterprises which carry on the whole range of production from the raw material to the finished product, so that the turnover is not subject to frequent charges. Such measures have brought about a similar concentration in trade, as they have resulted in many liquidations of smaller firms.

The rôle played by the banks in these fusions, amalgamations, and absorptions is much less important than in peace times; firstly, because the undertakings in question have as a rule made such large war profits that they can dispense with the assistance of banks; and, secondly, because the banks themselves are undergoing a process of concentration, which is, however, being carried on below the surface. The chief reason for this tendency toward concentration is that the problems confronting German finance on the conclusion of peace (the problems connected with supplies of raw materials, resumption of issue, reconstruction of credit organization, etc.) can be accomplished only by institutions of extraordinary capacity and internal strength. The result of this must perforce be a further reduction in the number of medium-sized houses.

Recent Metallurgical and Chemical Patents

Potash

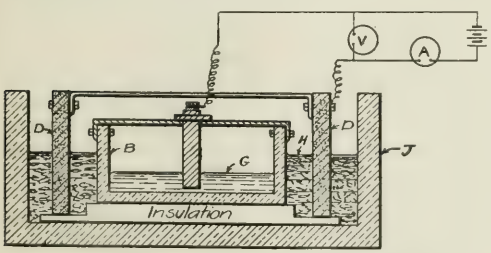
Potash from Kelp.—A method for the production of potash from kelp by the use of electrical endosmose is patented by HARLAN L. TRUMBULL of Seattle, Wash.

The moist kelp, which may or may not be freshly harvested (preferably after first being ground or cut into pieces of conveniently small size), is pressed into the anode compartment of a suitable, divided-electrolytic cell wherein it makes intimate contact with and moistens a porous partition.

The container J (Fig. 1) may consist of any material not already attacked by chlorin.

The anode D may consist of any electrode material which is relatively inert chemically in the presence of free chlorin, such as amorphous carbon, graphite or cast magnetite.

The cathode G is of mercury and during electrolysis makes intimate contact with the above-mentioned porous partition on the opposite side from the kelp indicated by H. By electrolysis, mercury is converted into an amalgam of alkali metals, which amalgam is decomposed in the presence of water to furnish a solution of alkalis. This decomposition may be hastened by the use of contact agents such as graphite, carbon, nickel or certain other solids. The decomposition of the amalgam may be effected either during the electrolysis or after its completion. In either case the resulting solution is a mixture of alkalis containing a high percentage of caustic potash. The alkalis may be obtained in solid form by evaporating the solution to remove water and other volatile substances which are present.—(1,238,600, Aug. 28, 1917.)



CROSS-SECTION OF KELP-TREATING APPARATUS

Potash from Refuse Slate Dumps.—FRANK G. BREYER of Palmerton, Pa., has patented a method for recovering potash from carbonaceous material and refuse, such as shales, slates, peats, waste coal, culm, etc. He proposes to burn the material in a blast or other type of furnace with suitable additions of limestone to from a slag with the ash in the charge. The potash is volatilized and is caught in dry dust catchers or wet gas scrubbers, or in a Cottrell apparatus.—(1,236,903, Aug. 14, 1917.)

Potash from Feldspar.—WALTER GLAESER of Brooklyn, N. Y., patents a process of producing potash from feldspar. The process consists in burning the material at a low red heat, then suddenly cooling the heated material, mixing burnt lime with the material in the proportions of less than 20 per cent, fusing the mixture at 1600 deg. C. and then subjecting the ground product to the action of sulphuric acid to form potash alum. The material may be used for fertilizer before making potash alum if desired, and is stated to give good results.—(1,237,197, Aug. 14, 1917.)

Petroleum Technology

Preventing Sedimentation.—ARTHUR L. BROWN of Wilkinsburg, Pa., patents a method of treatment of hydrocarbon oils for the prevention of sedimentation. The patent is assigned to the Westinghouse Electric & Mfg. Co.

When hydrocarbon oils are exposed to the air they slowly develop a dark sediment or sludge which appears to result from a slight oxidation of the oil. When such oils are used for cooling purposes, as in the tanks of electric transformers, the sediment may accumulate upon the walls of the container and cooling coils to such an extent as to greatly interfere with the dissipation of heat. According to this patent the formation of sediment in hydrocarbon oils may be prevented by the presence of small amounts of phosphorus. The amorphous or red phosphorus is used, and only a small fraction of 1 per cent of the weight of the oil is necessary to accomplish the desired result. The phosphorus may be mixed with the oil, or it may be made into a paste with glue or other suitable binder and painted upon the inner walls of the containers that are to receive the oil.—(1,234,862, July 31, 1917.)

Treatment of Oils in Presence of Aluminium.—A. M. MCAFEE of Bayonne, N. J., patents a process of oil treatment for gasoline production, using aluminium as a catalyzer, and introducing a current of chlorine gas into the oils. The operation is carried out in the regular still. The low boiling products and the hydrochloric acid produced being removed continuously during the progress of the reaction, and the volume of the

oil being kept constant by fresh additions. It is claimed that by this process gas oil is converted into gasoline with about an 85 per cent conversion. About 10 per cent of the oil is converted into gas, which may be used for heating purposes and the residue forms granules of coky carbon.

It may be that some of the catalytic action is due to the direct production of aluminium chloride in the body of oil, or it may be that the action of the aluminium on the oil in this operation is direct. It is stated, however, that the aluminium appears to exercise more catalytic activity in this process than would result from the use of a corresponding amount of aluminium chloride.

Zinc or iron may be used in lieu of aluminium, but are less advantageous. When used they are employed in the same manner as aluminium.—(1,235,523, July 31, 1917.)

A New Optical Pyrometer

An optical pyrometer for works use has been developed by the Leeds & Northrup Co., Philadelphia, Pa.

In the focal plane of a small telescope is placed the filament of a small tungsten lamp, the current for which is supplied by a storage battery carried in a case slung from the shoulder. By means of a rheostat, the observer adjusts the current through the lamp until the filament merges or disappears in the background formed by the object looked at, and thereupon reads the current from a milliammeter mounted upon the battery case. A calibration chart converts the milliammeter reading temperature.

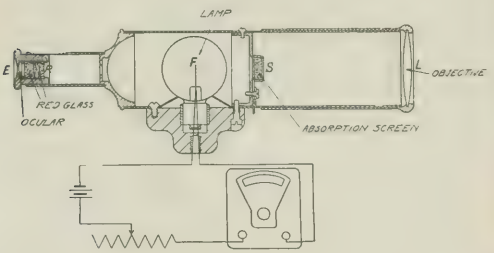


FIG. 1—OPTICAL SYSTEM AND ELECTRICAL CIRCUIT OF OPTICAL PYROMETER

It is stated that the setting can be made with great precision, due to the rapid change in the intensity of light emitted by the hot objects with change in temperature and to the sensitiveness of the eye in differentiating the brightness of superposed objects. A color screen is interposed between the eye and the focal plane so that only monochromatic light reaches the eye. Color blindness, therefore, is no hindrance to the use of the instrument, and it is claimed that different observers agree within 3 deg. C. The observer can stand 5,100 or 200 feet from an ingot, billet or furnace and get the temperature. The range is from about 1100 deg. Fahr. to the highest known temperature.

For temperatures above 2500 deg. Fahr. a dark screen is used to reduce the intensity of the light received from the hot object.

A Tin Pyrometer

An expansion pyrometer using tin as the expansion element has been developed and placed on the market by the Pyrolectric Instrument Co., of Trenton, N. J. Advantage has been taken of the fact that the thermal expansion curve of tin is practically a straight line. In this new pyrometer, tin is contained in a graphite bulb much as you would contain mercury in a glass tube in a mercury thermometer. The tube up which the melting tin rises is an open system, of graphite. Readings are made by lowering the plunger with a metal of a high melting point at the lower end, this metal making electrical contact with the rising tin, closing a circuit. Readings are then made in one of two ways. If you would want to know when 1500 deg. C. is attained, you would set the pointer on the scale at 1500 deg. C. When

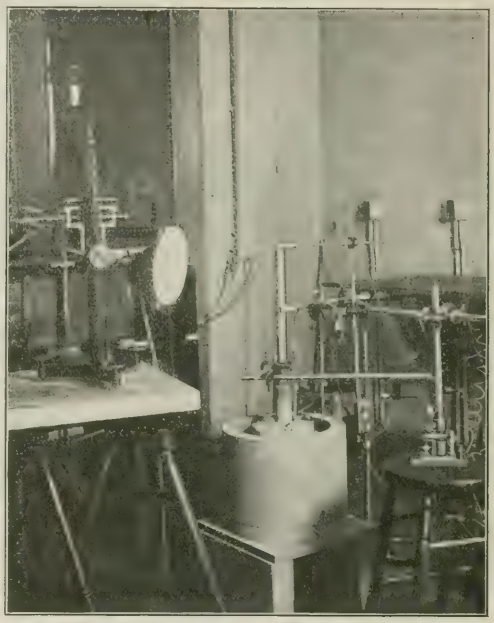


FIG. 1—CALIBRATION OF TIN PYROMETER IN NORTHRUP-AJAX FURNACE

this temperature is reached, a buzzer, or any form of electrical alarm, is set into operation. To find the temperature at any time, the pointer is lowered on the scale until the alarm rings. The position of the pointer then indicates the true temperature of the tin at the time.

It is pointed out by the manufacturers that this form of pyrometer opens up possibilities for reading temperatures some 300 deg. above thermocouple limits, with a direct insertion pyrometer. It is especially adapted for integrating a mass temperature, rather than for finding a point temperature, as with a thermocouple. The expansion of the graphite is almost negligible in comparison with that of the tin. The tin does not appreciably evaporate until a temperature of presumably 2000 deg. c. is reached so that no difficulty in change of calibration is encountered.

Personal

Mr. **Lawrence Addicks,** consulting metallurgical engineer of New York City, has gone to Burma to make a metallurgical investigation of the ores of the Bawdwin Mines. He expected to sail from Vancouver on Oct. 25.

Mr. **H. F. Bardwell,** who is well known to the buyers of tool steel in the East, has been appointed New York district manager for the Vanadium-Alloys Steel Co. of Pittsburgh and Latrobe, Pa., with offices at 30 Church Street, New York, N. Y.

Mr. **Max H. Boehme**, manager of the Seattle office of Marden, Orth & Hastings Corp., recently spent a few days at New York headquarters.

Mr. **Charles C. Cheyney,** manager of the Chicago office and store of the Buffalo Forge Company, has a commission in the Naval Aeronautic Corps and is Beach Engineer at Pensacola, Fla., in charge of aeroplane engines.

The appointment of **Burwell S. Cutler** of Buffalo as chief of the Bureau of Foreign and Domestic Commerce, Department of Commerce, was confirmed by the Senate recently. Mr. Cutler, who is well known in manufacturing circles in western New York, came into the Bureau six months ago at a nominal salary to assist in putting the organization on a thoroughly business basis. He was made first assistant chief, but since the resignation of Dr. E. E. Pratt, has been acting chief. Mr. Cutler was born in Buffalo and finished his scholastic education at Lake Forest University and Harvard. For fifteen years he has been president of an important Buffalo manufacturing concern and has been identified in an official capacity with numerous business houses and civic organizations throughout New York State.

Dr. **Frederic Dannerth,** head of the Rubber Trade Laboratory in Newark, N. J., addressed the Philadelphia Section, American Chemical Society, on Oct. 18, at the Houston Club, on "The Financial Prospects of Synthetic Rubber." At the same meeting Mr. **G. A. O'Reilly** of the Foreign Trade Department, Irving National Bank, N. Y., spoke on "The Industrial Chemist as Seen by the Banker."

Dr. **Milton W. Franklin,** who has been engineer of the Ozonator Department of the General Electric Co., has gone to E. F. Houghton & Co. of Philadelphia as consulting engineer. Dr. Franklin becomes a member of the Board of Directors, chairman of the Sales Committee, and assumes charge of plants and equipment and manufacturing processes.

Mr. **C. F. Goodrich,** assistant manager of the Buffalo Forge Company's Boston office, has left for active duty as First Lieutenant in the Ordnance Department, and is stationed at the Watervliet Arsenal.

At the annual meeting of stockholders of the Semet-Solvay Company, Syracuse, N. Y., **Alfred W. Hudson,** president of the First National Bank, was elected a member of the Board of Directors to succeed **Frederick R. Hazard,** deceased.

Dr. **James J. Johnson**, 549 Summer Avenue, Newark, N. J., formerly connected with the Maas & Waldstein Company in the capacity of chief chemist, has been commissioned a Captain in the Ordnance Department, to serve in the gun division. Dr. Johnson is an expert on high explosives, having been formerly associated with the duPont plants and also at the Picatinny Arsenal.

Mr. **E. K. Judd** of the Mining Department of Columbia University has been appointed managing editor of the *Bulletin* of the American Institute of Mining Engineers, vice B. A. Robinson, who resigned in June. Prof. G. A. Roush, who has been acting temporarily as managing editor since Mr. Robinson resigned, will resume his usual duties in Lehigh University.

Mr. **P. J. Kroll** has resigned as Pittsburgh and Middle West representative of the International Oxygen Co. of New York.

Mr. **H. E. Linden** of the Beckman & Linden Engineering Corporation of San Francisco, is making an extended trip throughout the East in the interest of his own company and also in the interest of the Pacific Electro-Metals Company of which the Beckman & Linden Engineering Corporation are engineers and managers.

Dr. **Ralph H. McKee** has been appointed to take charge of the graduate work in industrial organic chemistry (Department of Chemical Engineering) at Columbia University, New York City. Dr. McKee was at the head of the Department of Chemistry of the University of Maine from 1909 to 1916, leaving this position a year ago to enter commercial chemical work in New York City as head of the research department of the Tennessee Copper Company. While at Maine he initiated and developed the department for the making of pulp and paper, the first of its kind to be established in any college in this country.

Mr. **Don R. Marsh,** production manager with the Buffalo Forge Company, has given up his work to assume similar duties at Washington in the production of ammunition. Mr. Marsh will receive a Captain's commission.

Mr. **Harry W. Newton** has joined the staff of Falkenburg & Laucks, chemists and metallurgists, Seattle, Wash. Mr. Newton has had a long experience in the treatment of ores of the Northwestern territory. Mr. Newton first successfully worked out the treatment of Republic ores and has also done a great deal of work on ores of British Columbia and Alaska. Mr. Newton will have charge of the ore-testing department of Falkenburg & Laucks.

Messrs. **Philip A. Singer** and **Harris Perlstein,** formerly of the Industrial Chemical Institute of Milwaukee, have associated as Singer-Perlstein Company, chemical and industrial engineers, with offices in the Railway Exchange, Milwaukee. Mr. Singer was for many years with the Corn Products Refining Company as member of the Manufacturing Committee and superintendent of various departments of that corporation's plants. He has also made contribution to the technique of the ethyl alcohol from wood waste and other chemical industries. Mr. Perlstein has been connected with Mr. Singer in a number of recent enterprises.

Dr. **Reston Stevenson**, assistant professor in charge of physical chemistry in the College of the City of New York, has been appointed Captain of the Sanitary Corps of the United States Army.

Imports of Raw Materials Pass the Billion-Dollar Mark

For the first time in the history of American trade the imports of raw materials passed the billion-dollar mark during the fiscal year 1917. According to statistics published by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, the exact total was $1,109,655,040, a noteworthy increase over the $948,825,500 in 1916 and the $632,865,860 in 1914, the last normal year before the war.

The raw materials now imported in the greatest quantities are hides, India rubber, raw silk, wool, raw cotton, copper ore and flax-seed, and important increases are recorded for furskins, gums, mineral oils, uncut diamonds, manganese ore, nickel ore, zinc ore, and dyewoods.

IMPORTS OF CRUDE MATERIALS

	1917		1914	
Hides, lbs.	700,207,497	$216,363,609	561,070,686	$120,289,783
India rubber, lbs.	333,373,711	189,328,674	131,995,742	71,219,851
Silk, raw, lbs.	33,568,885	156,085,649	28,594,672	97,828,241
Wool, unmanufactured, lbs.	372,372,218	131,137,170	247,648,869	53,190,767
Fibers, unmanufactured, tons	408,618	67,709,758	418,432	54,349,995
Cotton, raw, lbs.	147,061,635	40,429,526	123,346,899	19,456,588
Copper ore, tons	613,593	32,576,082	478,679	13,696,984
Flaxseed, bu.	12,393,988	25,149,669	8,653,235	10,571,410
Furskins, undressed	.....	21,553,375	.....	8,540,321
Gums, crude	.....	18,644,347	.....	11,992,777
Mineral oils, gals.	1,034,590,849	14,109,035	773,052,480	11,776,737
Diamonds, uncut	.....	11,717,175	.....	7,519,688
Manganese ore, tons	656,088	10,545,986	288,706	1,841,451
Nickel ore, tons	60,132	9,970,957	36,420	6,109,547
Zinc ore, tons	324,767	7,596,930	18,280	251,479
Dyewoods, tons	131,689	4,326,576	37,725	486,992

CURRENT MARKET REPORTS

The Iron and Steel Market

Unlike the case of coal, price-fixing in the iron and steel industry is proving rather a satisfactory performance for all parties concerned, there being little friction and only occasional complaint. The complaint, such as there is, comes from buyers rather than sellers, and seems to arise chiefly from misunderstanding of the principles involved. Some buyers complain, for instance, that they cannot make purchases from mills, but are forced to buy from warehouse, and when the warehouse chances to be conducted by a steel-producing interest they question whether it is not a violation of the agreement for the warehouse price to be higher than the mill prices agreed upon. The fact is that nothing has been done with respect to regulating jobbers' selling prices, and it is quite possible that nothing will be done.

The essence of the various agreements being reached between the Government and the iron and steel producers is that they will sell to the Government and its Allies at the set prices, and that in case they sell to the general public it will be at prices not higher than those set. The producers do not agree to sell to the public; they agree that when they sell it will be only under certain limitations. Whether they sell or not depends upon the amount and character of their obligations already on books and the desire they may have to take care of regular customers.

Set prices were announced Sept. 24 of $33 on pig iron and 2.90c., 3c. and 3.25c. on bars, shapes and plates respectively, and Oct. 11 of $47.50 for 4 x 4 billets and larger, $50 on slabs, $51 on sheet bars and small billets, and 2.90c., 3.15c. and 3.25c. for grooved, universal and sheared skelp respectively. Pending the announcing of further details foundry and basic iron is held to be at $33 at all furnaces and Bessemer at $36.30 or 10 per cent higher. Rods are supposed to be based on Pittsburgh, other unfinished steel, and skelp, on Pittsburgh or Youngstown, and bars, shapes and plates on Pittsburgh or Chicago. This distinctly novel departure of making Chicago a basing point equal with Pittsburgh is not universally accepted in the trade as final.

BUSINESS AT NEW PRICES

There has been a fair run of pig iron business at the new prices, probably on the whole a materially larger turnover than was passing through the market before the price agreement was reached. The market had been decidedly stagnant for nearly three months. In unfinished and finished steel, on the other hand, the market has been extremely quiet and sales have been the exception rather than the rule. Some sales have been made, but in the majority of instances they were probably sales made in connection with Government orders. Before price regulation was undertaken there were certain tentative prices the Government was prescribing upon certain descriptions of steel intended eventually for war use, and manufacturers who bought steel and sold their finished product to the Government were expected to get the benefit of these special prices, documentary evidence being required by the steel mill that the material involved was for Government use. With the "one price for all" system in force such proof is requisite only in connection with priority of delivery.

ATTITUDE OF PRODUCERS

Iron and steel producers frankly admit that the new prices are quite satisfactory to them. There is an indisposition to discuss details, but there is no question that one reason why the Government regulation is accepted in such good part is that it removes a menace from the market, that in its reaction from the fictitious prices that had come to be quoted as "the market" there would have been found no definite place for the market to stop in its decline, and much confusion might have resulted. The steel makers are not allowed to combine to regulate prices, and even the "Gary Dinners" of nearly ten years ago have been frowned upon by the courts, even though those dinners were not held for the purpose of setting or fixing prices, but merely for the purpose of stimulating enthusiasm on the part of individual sellers, to adhere to prices which the market had already established. The steel makers have learned how to adhere to recognized prices, without holding meetings and making agreements, but they cannot adhere to something that does not exist. Given a schedule of prices that is prescribed as maximum they will be indisposed to regard these prices as otherwise than minimum prices also. Thus they are given a definite basis, something hitherto lacking.

ATTITUDE OF CONSUMERS

Consumers are making no particular effort to buy for forward deliveries, and the call for material for early deliveries is decidedly less than it was even a very few weeks ago. The rate of consumption of steel, for ordinary peace purposes, is undoubtedly declining, on the whole, and perhaps at rather a rapid rate. The

fact that the Government's set prices are distinctly stated to be subject to revision Jan. 1 or later tends to dispose buyers to hold off, except as to earlier deliveries, while at the same time it gives the mills a reason for not considering forward sales, on the ground that the object of price-fixing is to put all buyers, eventually, on the same basis, and if prices are to be revised Jan. 1 sales for delivery beyond that date would at once divide buyers into two classes.

The whole trend of the situation, under the system of fixed prices, is to reduce the volume of forward commitments and bring the market more to a hand-to-mouth basis. The buying pressure does not furnish the usual index as to prospective consumptive requirements. In many directions these will necessarily be large. While building operations have been decreasing constantly, and are unlikely to be heavy at any time during the war, mines and factories are, in the main, to operate at the fullest possible gait, and their upkeep involves the use of much steel. Transportation facilities must be maintained, increased if possible, and that must involve the consumption of much steel if the object is attained.

THE RAILROADS

There is very little light on the prospective iron and steel demands of the railroads. For several months they have been buying scarcely anything, and there have been no large orders for rolling stock since the early months of the year, except the purchases by the Government and its Allies, which are hardly likely, for any length of time, to equal the ordinary buying of the domestic roads. The Interstate Commerce Commission is to open the 15 per cent rate advance cases, the first hearings being scheduled for Nov. 5, but whether this will result in the railroads being given the relief they insist they should have is a question. There is talk of the Government financing some railway purchases, particularly of rolling stock, but some of the railroads explain that they want to make money, not borrow it, and if they can only buy what they need by the Government lending them money it means eventual Government ownership. It seems far from improbable that the status of the railroads, as to buying of iron and steel, will not be established until there is Congressional legislation at the coming session, either by way of directing the Interstate Commerce Commission to arrange rate advances on the ground that the gold dollar is permanently depreciated, or accepting responsibilties, by way of railway financing, that may lead to eventual Government ownership. Meanwhile the prospective consumption of steel for commercial purposes, say over the next twelvemonth, can hardly be gaged when so important a line of consumption is surrounded with such doubts.

PRODUCTION

October, traditionally the month in the year of record outputs, has made a sorry showing, with no material increase over the rates of the summer months. While there are many difficulties in the way of full production, coke is easily the dominant factor. There is not sufficient coke to supply all the furnaces able otherwise to operate, and steel production is correspondingly curtailed. With the most conservative estimates of productive capacity, the actual production in both pig iron and steel is not over 90 per cent of capacity, while some estimates are on the basis that steel production at least is only between 80 and 85 per cent of capacity. Thus far this year the output of pig iron has been slightly less and the output of steel slightly greater than in the corresponding period of last year, although capacity is greater through the new construction.

Non-Ferrous Metal Market

Friday, Oct. 26.—An interesting development in the resale of copper was brought about a few days ago when Eugene Meyer, Jr., in charge of the regulation of non-ferrous metals, issued a letter to a firm of metal brokers stating that metals sold above the prices fixed by the Government are liable to seizure.

The statement of Mr. Meyer clears up a much disputed point in the copper trade. Leading copper authorities who were informed of the opinion expressed by Mr. Meyer were not disposed to agree with him as to power of the Government to seize metal sold above the fixed prices in cases where the seller had purchased the metal above the fixed figures.

That Mr. Meyer's warning of seizure is not being seriously regarded is evidenced by sales of spot copper recently at 26 cents to as high as 29 cents. Some consumers are willing to pay premiums for spot metal as they face the alternative of either closing their plants or conceding the price asked by holders of spot metal.

The next thing that the metal trade is looking for is an announcement from Washington of a census on all metal holdings in the country. Although no official word has been given out on this score, it is learned that details of stocks of metals held by consumers and dealers on a certain date are essential before Government control of the metals will be running smoothly.

Copper.—As stated above, spot copper has changed hands at prices ranging from 25 cents up to probably 29 or 30 cents. However, these are resale lots and practically no copper can be purchased from producers at any price. This condition is very serious for consumers needing supplies as most of them are afraid to buy any copper at over the Government price of 23.50 cents. A new ruling by the Government is badly needed to relieve this situation.

Tin.—Arrivals in October up to the 23rd were very low, totaling only 1900 tons, with 4300 tons afloat. Following a period of dullness about a week ago, the market has become firmer and a steady demand has developed. Banca tin is scarce and 60 cents has been bid for it. Chinese No. 1 is extremely scarce. Spot Straits is quoted at 61.62½ cents.

Lead.—The Trust further reduced its price on Oct. 18, making it 6.50 cents, New York. The outside market is 6.25 cents. The market is unsettled.

OTHER METALS

Antimony, Chinese and Japanese, pound	0.14—0.14¼
Aluminium, No. 1 Virgin, 98-99 per cent, pound	0.37—0.39
Magnesium, metallic, pound	2.00—2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask	100.00
Silver, ounce	0.82½
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

Spelter.—The spelter market has been very dull. Producers are not interested in selling at present prices as they are very near production costs. The normal quotation for prompt spelter is 8.25 cents, New York.

Chemical Market

Coal Tar Products.—Coal tars with the exceptions of Phenol, Naphthalene and Toluol have generally been subject to decline, owing to the export restrictions and difficulties in securing permits partly to Japan and Spain, which countries have been heavy buyers in this market for the past few months.

Benzol.—Values in this market are considered rather low, with quantities having accumulated, owing to the fact that the export movement is more or less suspended.

Aniline Oil.—Stocks are rather large in some quarters, and as this product is one requiring a license for export it does not show much improvement.

Benzoate of Soda.—A decidedly upward turn has been noted in this market, a prediction of a number of the more important factors. Some of the smaller producers not financially sound have been forced out.

Dintrochlorbenzol.—Demand is not very heavy and prices are not particularly strong, owing to difficulty in securing export licenses.

Toluol.—A fair movement is noted in this product and the general demand has improved somewhat, but the greater part of the production is going into the manufacture of explosives.

Monochlorbenzol.—It is indicated from various sources that stocks are quite ample, however, there does not seem to be a gratifying movement into consuming channels.

Orthonitrophenol.—A firm situation is noted with supplies scarce and efforts to locate material have been without results. One of the producers making the para and ortho recently sustained a loss by fire, and this tended to strengthen an already firm market.

Naphthalene.—A very firm market seems to prevail and some of the leading interests are inclined to sit tight rather than sell at figures generally quoted.

Phenol.—The situation seems to be gradually growing firmer and the production has been well sold up for the first half of the coming year and considerable business has been booked during the past fortnight.

Dinitrophenol.—The product has been in better demand for the fortnight and prices quoted seem to be firmer.

Heavy Chemicals.—There has been a general reduction in all products which come under this classification, principally due to difficulties encountered in securing licenses and to the export restrictions imposed by the Government.

Acids.—Enormous demand from both foreign and domestic sources have swamped the markets for nitric, muriatic and sulphuric acids, including oleum. Prices have advanced for all grades.

Caustic Soda.—Not much of a recovery is noted and the market continues rather weak owing to the embago placed by the Government, which absolutely prohibits the exportation of this product and little business of any consequence is passing.

Soda Ash.—A very uncertain situation exists and business is somewhat weakened, spot material being very scarce and special interests do not seem quite so bold.

Bleaching Powder.—The market for this product continues to be rather neglected and prices have dropped to a low level. Stocks are ample and buyers do not show much interest.

Cyanides.—An easier market prevails with more liberal offers of the soda and mixture. The potash continues scarce, however, and but little is available.

Bichromate of Soda.—A sharp decline is noted in this market, and prices named are at a low level.

Bichromate of Potash.—A weaker tone is noted and prices are not quite as firm as of a fortnight.

Chlorates.—There seems to be a downward movement in both potash and soda and prices are somewhat lower.

Copper Sulphate.—A very firm market is reported in this product and most of producers are not inclined to quote.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET OCT. 25, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.36 —	.37
Acid, acetic, 28 per cent	lb.	.06 —	.06½
Acetic, 56 per cent	lb.	.11 —	.12
Acetic, glacial, 99½ per cent, carboys	lb.	.38 —	.40
Boric, crystals	lb.	.12½—	.14
Citric, crystals	lb.	.72 —	.72½
Hydrochloric, C.P	lb.	.08 —	.08¼
Hydrochloric, 20 deg	lb.	.02½—	.02¾
Hydrochloric, C.P., conc., 22 deg	lb.	.02¼—	.02¾
Hydrofluoric, 30 per cent, in barrels	lb.	.06 —	.06¼
Lactic, 44 per cent	lb.	.12 —	.15
Lactic, 22 per cent	lb.	.06 —	.06½
Nitric, 36 deg	lb.	.07½—	.07¾
Nitric, 42 deg	lb.	.08¾—	.09¼
Oxalic, crystals	lb.	.43 —	.45
Phosphoric, 47 per cent-50 per cent	lb.	.07½—	....
Picric	lb.	.63 —	....
Pyrogallic, resublimed	lb.	3.10 —	3.15
Sulphuric, 60 deg	ton	25.00 —	27.00
Sulphuric, 66 deg	ton	35.00 —	36.00
Sulphuric, oleum (Fuming), tank cars	ton	55.00 —	....
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.78½—	.81
Tungstic, per lb. of W	lb.	1.80 —	1.90
Alcohol, grain, 188 proof	gal.	4.30 —	4.35
Alcohol, wood, 95 per cent	gal.	1.20 —	1.25
Alcohol, denatured, 180 proof	gal.	.95 —	1.00
Alum, ammonia lump	lb.	.04¼—	.04½
Alum, chrome ammonium	lb.	.18½—	.19
Alum, chrome potassium	lb.	.23 —	.24
Alum, chrome sodium	lb.	.12½—	.13
Alum, potash lump	lb.	.08 —	.09½
Aluminum sulphate, technical	lb.	.02 —	.02½
Aluminum sulphate, iron free	lb.	.03½—	.04
Ammonia aqua, 26 deg. carboys	lb.	.14 —	.15
Ammonium carbonate	lb.	.12½—	.13
Ammonium nitrate	lb.	.22 —	.24
Ammonium, sulphate domestic	lb.	.07 —	.07½
Amyl acetate	gal.	4.75 —	5.00
Arsenic, white	lb.	.16½—	.17
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	70.00 —	....
Barium carbonate 97-98 per cent	ton	65.00 —	....
Barium chloride	ton	73.00 —	83.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.11½—	.12½
Barium peroxide, 85-88 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼—	.01½
Borax, crystals, sacks	lb.	.07½—	.08½
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.65½—	.75½
Calcium, acetate, crude	lb.	.06 —	.06½
Calcium, carbide	lb.	.08 —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.33 —	.35
Calcium sulphate	lb.	.... —	....
Carbon bisulphide	lb.	.07½—	.08½
Carbon tetrachloride, drums	lb.	.16¾—	....
Caustic potash, 88-92 per cent	lb.	.85 —	.87
Caustic soda, 76 per cent	lb.	.07¾—	.08
Chlorine, liquid	lb.	.16 —	.24
Cobalt oxide	lb.	1.40 —	1.50
Copperas	lb.	.01¼—	.01½
Copper carbonate	lb.	.30½—	.32
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09 —	.09½
Cream of tartar, crystals	lb.	.52 —	.53
Epsom salt, bags	lb.	.03¾—	.04
Formaldehyde, 40 per cent	lb.	.16 —	.17
Glauber's salt	lb.	.01¼—	.01¾
Glycerine, bulk, C. P.	lb.	.70 —	.71
Iodine, resublimed	lb.	3.50 —	3.75
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17½—	.18½
Lead arsenate	lb.	.15 —	.18
Lead nitrate	lb.	.17½—	.18
Litharge, American	lb.	.10½—	.12¼
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P.	lb.	.48 —	.55
Magnesium carbonate, tech	lb.	.11 —	.12½
Nickel salt, single	lb.	.14 —	.16
Nickel salt, double	lb.	.11 —	.13
Phosphorus, red	lb.	1.70 —	....
Phosphorus, yellow	lb.	2.10 —	2.20

Potassium bichromate	lb.	.44	—	.45
Potassium bromide granular	lb.	1 35	—	1 40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2 60	—	2.70
Potassium iodide	lb.	2 90	—	3 00
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	325 00	—	350 00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4 00
Potassium prussiate, red	lb.	2 70	—	2.80
Potassium prussiate, yellow	lb.	1.25	—	1.30
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.10½	—	.11½
Salammoniac, white gran	lb.	.15	—	.16
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1 10	—	1.15
Silver cyanide, based on market price of silver.	oz.			
Silver nitrate	oz.	.53	—	.54½
Soda ash, 58 per cent. light, flat	100 lb.	3 10	—	3 20
Soda ash, 58 per cent, dense, flat.	100 lb.	3 90	—	4.00
Sodium acetate	lb.	.13½	—	.14
Sodium benzoate	lb.	1.75	—	2 00
Sodium bicarbonate, domestic	100 lb.	2 65	—	2.85
Sodium bicarbonate, English	lb.			
Sodium bichromate	lb.	.19½	—	.21
Sodium bisulphite, powd	lb.	.04½	—	.05
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.90	—	5.00
Sodium nitrite	lb.	.35	—	.36
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.35	—	.37
Sodium silicate, liquid		.04½	—	
Sodium sulphide, 30 per cent crystals	lb.	.02¼	—	.02¼
Sodium sulphide, 60 per cent, fused	100 lb.	3 75	—	4.00
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.25	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4 10	—	4 15
Sulphur, roll	100 lb.	3.75	—	4 10
Sulphur, crude	ton	60 00	—	65 00
Tin bichloride, 50 deg.	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.24	—	.25
Zinc chloride	lb.	.15½	—	.17
Zinc cyanide	lb.	.50	—	
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.06	—	.06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.45	—	.50
Benzol, 90 per cent	gal	.50	—	.52
Toluol, pure water white	gal	1 80	—	1.85
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P.	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.10		
Alpha naphthol, distilled	lb.	1.60		
Alpha naphthylamin	lb.	.60	—	.62
Aniline oil	lb.	.25	—	.28
Aniline salts	lb.	.31	—	.32
Anthracene, 80 per cent	lb.	.10	—	
Benzaldehyde	lb	4.00	—	4.50
Benzidine, base	lb.	1.60	—	1.80
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	2.00	—	2.25
Benzyl chloride	lb.	1.75	—	2 00
Beta naphthol benzoate	lb.	6 50	—	8.50
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com.	lb.	2 50	—	
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3.75	—	4 25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.42	—	.44
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.62
Dimethylaniline	lb.	.57	—	.59
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09½	—	.10
Naphthionic acid, crude	lb.	1.50	—	1.75
Naphthylamin-disulfono acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.			
Ortho-toluidine	lb.	.85	—	.90
Orth-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Para amido-phenol, H. Cl	lb.	5.25	—	5.75
Paranitraniline	lb.	1.10	—	1.15
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.25
Phenol, U. S. P.	lb.	.51	—	.52
Resorcin, technical	lb	8.00	—	9.00
Resorcin, pure	lb.	13.50	—	15.00
Salicylic acid	lb.	1.25	—	1.35
Salol	lb.	2.00	—	2.25
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3 50	—	...
Corning, Ohio	bbl.	2 60	—	....
Somerset, Ky.	bbl.	2 40	—	....
Wooster, Ohio	bbl.	2 38	—	....
Indiana	bbl.	1 98		....
Illinois	bbl.	2 12	—	..
Oklahoma and Kansas	bbl.	2 00	—	.
Caddo, La., light	bbl.	2 00	—	..
Corsicana, Tex., light	bbl.	2 00		
California	bbl.	98	—	1 32
Gulf Coast	bbl.	1 00	—	..
Fuel Oil				
New York	gal.	10½	—	
Pittsburgh	gal.	07½		10
Oklahoma-Kans	bbl.	70		1 55
Texas	bbl.	1 60		
Los Angeles	bbl.	1 45		
San Francisco	bbl.	1 45	—	.
Gasoline (Wholesale)				
New York	gal.	24	—	.
Boston	gal.	25	—	.
Pittsburgh	gal.	24	—	.
Chicago	gal.	21	—	.
Oklahoma	gal.	23	—	
San Francisco	gal	20	—	

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13½	—	14
Cylinder, light	gal.	21	—	26
Cylinder, dark	gal.	18	—	19
Paraffine, high viscosity	gal.	.29½	—	30
Paraffine, .903 sp. gr	gal.	.21½	—	22
Paraffine, .865 sp. gr	gal.	.18½	—	19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	.
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	.
Pine oil, destructively distilled	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	
Wood creosote, ref. f.o.b. Florida	gal	.50½	—	

Vegetable and Other Oils

China wood oil	lb.	.21	—	.22
Cottonseed oil, crude	gal.	1 15	—	1.17
Linseed oil, raw, cars	gal.	1 12	—	1 14
Peanut oil, crude	gal.	1 25	—	
Rosin oil, first run	gal.	.35	—	
Rosin oil, fourth run	gal.	.66	—	
Soya bean oil, Manchuria		.15	—	.15½
Turpentine, spirits	gal.	.54½		

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00		36.00
Beeswax, white, pure	lb.	.65	—	68
Carnauba wax, flor	lb.	.55		
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.			
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb.	bbl.	6.75	—	
Soapstone	ton	10 00	—	12 50
Talc, American, white	ton	15.00	—	18 00
White lead, dry	lb.	.09		.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55 00
Clay brick, second quality	per 1000	35.00	—	40 00
Magnesite, raw	ton	30 00	—	35 00
Magnesite, calcined	ton	40.00		55 00
Magnesite, Grecian, dead burned	net ton	85 00	—	90 00
Magnesia brick, Grecian, 9x4½x2½	net ton	135 00	—	140 00
Silica brick	per 1000	50 00		60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160 00	—	....
Ferrochromium, per lb. of Cr	lb.	.35		.40
Ferromanganese, domestic, delivered	ton	300 00		....
Ferromanganese, English	ton	375 00	—	
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	230 00		260 00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200 00		250 00
Ferrosilicon, 50 per cent, contract	ton	100 00	—	150 00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.40		2 60
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00		7 50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3 50

Ores and Semi-finished Products

Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit.	ton			90
Manganese ore, 48 per cent and over, per unit.	ton			1 00
Manganese ore, chemical	ton			$100.00
Molybdenite, per lb. of MoS_2	lb.			2 20
Tungsten, Scheelite, per unit of WO_3	ton			26 00
Tungsten, Wolframite, per unit of WO_3	ton			24.00
Uranium oxide, 96%	lb.	3 25		3 60
Vanadium Pentoxide, 99%	lb.			10 50
Pyrites, foreign	unit	.16		16½
Pyrites, domestic	unit	.11	—	12

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The Advance Paper Tube & Can Manufacturing Company, Inc., New York. Capital, $25,000. To manufacture paper, cardboard and kindred products. Incorporators are: I. Silverstein, D. Gluckstein and F. Rothberg, 132 Greene Street, New York.

The Agricultural Chemical Company, Memphis, Tenn. Capital, $10,000. To manufacture chemicals and kindred products. Incorporators are: Henry L. Sanders, F. E. Brown, J. B. Kelly, Memphis, and others.

The American Glass Company, Seattle, Wash. Capital, $6,000. To manufacture glass and glass products. Incorporators are: James F. Dooley and Charles Holmberg, Seattle.

The American Lime & Potash Products Corporation, Roanoke, Va. Capital, $300,000. To manufacture lime, potash and their by-products. Incorporators are: F. M. Hughson, Roanoke, and E. S. Hamilton, Filbert, W. Va.

The American Standard Metal Products Corporation, Dover, Del. Capital, $21,000,000. To manufacture metal products of various kinds.

The Anniston Steel Products Company, Birmingham, Ala. Capital, $3,000,000. To mine for manganese, iron, steel, zinc, copper, tungsten and kindred metals. Incorporators are: C. A. Bingham, Walter M. Hood, E. S. Center, M. P. Randall, P. C. Covington, W. R. Lloyd and T. L. Stewart, Birmingham.

The Arcanum Oil, Gas & Refining Company, Arcanum, Ohio. Capital, $250,000. To operate an oil refining works.

The Bermuda Oil & Gas Company, Tulsa, Okla. Capital, $25,000. To operate an oil refining works and produce gas, etc. Incorporators are: J. E. Hildt, R. I. Taylor and F. M. Drane, Tulsa.

The Betzwood Film Company, Philadelphia, Pa. Capital, $500,000. To manufacture motion picture films. Incorporators are: F. R. Hansell, Philadelphia; J. V. Fimm and S. C. Seymour, Camden, N. J.

The Big Seven Lead & Zinc Company, Oklahoma City, Okla. Capital, $100,000. To mine for lead, zinc and kindred metals. Incorporators are: W. W. Oder and John Weaver, Oklahoma City; J. W. Gillum, Erick, and Perry C. Burks, Texolo.

The Bucyrus Steel Company, Bucyrus, Ohio. Capital, $50,000. To manufacture steel and steel products. Incorporators are: S. H. Tulles, W. B. Kinder, Ralph Burroughs, R. C. Hyatt and John M. Garfield, Bucyrus.

The Burlington Oil & Refining Company, Oklahoma City, Okla. Capital, $1,000,000. To develop oil lands, refine oil and produce gas. Incorporators are: W. D. King, R. R. Sims and H. W. Ferguson.

The Carlisle Tire & Rubber Company, Dover, Del. Capital, $200,000. To manufacture rubber tires and rubber products. Incorporators: L. B. Phillips and J. B. Bailey, Dover, Del.

The Coal Oil Manifold Company, St. Louis, Mo. Capital, $10,000. To manufacture kerosene engines, manifolds and kindred products. Incorporators: R. W. Morrison, Edward H. Gorse and W. S. McCall, St. Louis.

The Commonwealth Products Corporation, Dover, Del. Capital, $100,000. To manufacture iron, zinc and copper products. Incorporators: W. S. Randall, Portland, Me.; F. A. Armstrong, Wilmington, Del., and Clement M. Egner, Elkton, Md.

The Commonwealth Silica Company, Chicago, Ill. Capital, $1,500,000. To mine for silica, lime and other substances. Incorporators: P. Zak and L. L. and B. F. Cowan, Chicago.

The Culver Superior Glass Company, Westerville, Ohio. Capital, $100,000. To manufacture glass, etc. Incorporators are: John H. Roush, Gustav Meyer, J. Z. Kroumm, R. B. Adams, William D. Shaw and Thomas A. Tussey, Westerville.

The Davis Carbureter System Company, Wilmington, Del. Capital, $500,000. To manufacture automobile parts. Incorporators are: E. E. Wright, William F. O'Keefe and M. Gehrman, Wilmington.

The Delphi Independent Oil Company, Delphi, Ind. Capital, $20,000. To produce oil and kindred products. Incorporators: George Gay, Glen R. Cushman, James C. Smock and Grover C. Long.

The Drawn Metal Products Corporation, New York. Active capital, $250,000. To manufacture metal products of various kinds. Incorporators are: C. A. Mezger, H. Osswald, T. F. Crean, 359 Parkside Avenue, Brooklyn.

The Fleckenstein Visible Gasometer Company, Wilmington, Del. Capital, $200,000. To manufacture gasoline and other oil measuring devices.

The Freeland Foundry & Machine Company, Dover, Del. Capital, $50,000. To manufacture and repair engines of various kinds.

The Hale Petroleum Company, Dover, Del. Capital, $20,000,000. To refine oil, produce gas and their products.

The Hapgood Oil & Development Company, Oklahoma City, Okla. Capital, $500,000. To acquire oil and gas lands and develop same. Incorporators: C. M. Hapgood, New Healdton, Okla.; J. S. Strong, Oklahoma City, and Fred A. Gillette, El Reno, Okla.

The High Products Chemical Company, Newark, N. J. Capital, $100,000. To manufacture chemicals and allied products. Incorporators are: Carl Dorgschlag, William Gerlach and H. C. Pfaff, Newark.

The International Safety Railway Tie Company, Dover, Del. Capital, $1,000,000. To manufacture railroad and railway ties of all kinds.

The Jeanette Oil & Gas Company, Jeanette, Pa. Capital, $50,000. To develop oil and gas lands in Pleasant and Tyler Counties, W. Va. Incorporators: John W. Keltz, Henry Bozzan, R. M. Zimmerman, Jeanette; H. E. Marker and C. B. Hollingsworth, Greensburg, Pa.

The King Glass Company, Kokomo, Ind. Capital, $100,000. To manufacture glass of all kinds. Incorporators are: E. B. King, and C. D. and W. M. Wells, Kokomo.

The Kansas Light Oil Company, Wilmington, Del. Capital, $750,000. To manufacture petroleum, oils and all their by-products.

The Lamie Chemical Company, Huntington, W. Va. Capital, $50,000. To manufacture chemicals and allied products. Incorporators: R. D. Lamie, Huntington; A. T. Roberts, Marquette, Mich.; H. W. Shelton, Negaunee, Mich.; John Garvin, Ontonagon, Mich., and Dan H. Ball, Marquette, Mich.

The Lloyd Chemical Works, Inc., Belleville, N. J. Capital, $20,000. To manufacture chemicals, dyes and allied products. Incorporators are: M. and A. Vandeweghe and Ellis Lloyd, Belleville.

The Missouri Iron & Steel Company, Dover, Del. Capital, $6,000,000. To manufacture steel and iron products.

The Moss-Bell Chemical Company, Haledon, N. J. Capital, $100,000. To manufacture chemicals, dyestuffs and allied products. Incorporators: Percival J. Wood, Joseph Whitehead and Samuel Schiffer, Haledon.

The Natural Chemical Products Corporation, New York. Capital, $2,500,000. To manufacture chemicals and chemical products. Incorporators are: S. B. Howard, L. H. Gunther and Joseph Curtin, New York.

The Nitro-Phospho Corporation of New York, Newark, N. J. Capital, $125,000. To manufacture chemicals and their by-products. Incorporators: George R. Swain, C. Jacobe and J. I. Sipp, Newark.

The Oklahoma Gas Generator Company, Oklahoma City, Okla. Nominal capital, $5000. To manufacture gas generating machinery. Incorporators are: E. E. Blake, E. H. Carter and E. A. Wales.

T. J. Parker, Inc., New York. Capital, $10,000. To manufacture chemicals, etc. Incorporators: G. H. Town, T. J. Parker and E. S. Burke, 1146 Fifty-fifth Street, Brooklyn.

The Jack Patch Manufacturing Company, Dover, Del. Capital, $24,500. To manufacture a special automobile tire repair material. Incorporators are: J. R. and C. E. Jack and John A. Bower, Waukegan, Ill., and Thomas J. Killian and Louis B. Jolley, North Chicago, Ill.

The Phio Color Works, New York. Capital, $5,000. To manufacture dyestuffs and kindred products. Incorporators: L. W. Alexander, F. C. Simons and M. Winters, 595 Eastern Parkway, Brooklyn.

The Pocono Oil & Coal Company, Paterson, N. J. Capital, $500,000. To acquire oil and coal lands and develop same. Incorporators are: Sylvester J. Lane, William T. Armstrong and Albert E. Sleight, all of Paterson.

The Producers & Refiners Oil Company of Indiana. Warren, Ind. Capital, $250,000. To sink and operate oil and gas wells. Incorporators are: H. H. Markey, James W. Cunningham and Glenn Brown, Warren.

The Richey Construction Corporation, New York. Capital, $50,000. To construct and operate plants for the manufacture of gas, oil, etc.

The Rotary Tire & Rubber Company, Dover, Del. Capital, $1,000,000. To manufacture automobile tires and other rubber products.

The Sanitary Canning Machine Company, Dover, Del. Capital, $500,000. To manufacture special machinery for the canning of fruits, etc.

Slavin & Sipkin, Inc., Newark, N. J. Capital, $10,000. To manufacture paints, varnishes, etc. Incorporators: R. and I. Slavin and A. Sipkin, Newark.

The Southern Fibre & Manufacturing Company, Jacksonville, Fla. Capital, $50,000. To manufacture fibre. Incorporators are: C. S. Anderson, Jay Lyon and E. L. Anderson, Jacksonville.

The Square Turn Tractor Company, Dover, Del. Capital, $2,000,000. To manufacture tractors and tractor attachments. Incorporators are: L. B. Phillips and J. B. Bailey, Dover.

The Standard Shoe Buffing Machine Company, Dover, Del. Capital, $500,000. To manufacture machinery for the buffing of shoes.

The Van Oiler Company, Chicago, Ill. Capital, $25,000. To manufacture oiling machinery. Incorporators are: H. Elmer Hudson, Henry C. Heinemann and John C. Teevan, Chicago.

The Walker Chemical Company, Philadelphia, Pa. Capital, $10,000. To manufacture chemicals. Incorporators are: F. R. Hansell, Philadelphia, and S. C. Seymour, Camden, N. J.

The Wallace Company, Newark, N. J. To manufacture chemicals and allied products. William H. Wallace, principal incorporator.

Webster & Company, Philadelphia, Pa. Capital, $50,000. To manufacture chemicals and kindred products. Incorporators are: M. Mills, John Kearns and C. A. Murphy, Philadelphia.

Construction and Operation

Alabama

BIRMINGHAM.—The Lecroy Graphite & Mineral Company, recently incorporated with a capital of $250,000, is planning for the installation of an initial plant for the development of its graphite properties in Clay County, to cost about $50,000. Harry W. Myers is president.

ENSLEY.—The National Steel Products Company has had plans prepared for the erection of a new plant at Bessemer to be devoted to the manufacture of steel castings and railway appliances. A new 3-ton open-hearth furnace will be installed, and the initial works, which will be 40 x 150 ft., will have a capacity of 15 tons per day.

SHEFFIELD.—The United States Government has announced that a site has been selected on the Tennessee River, near Muscle Shoals, for the erection of its proposed experimental nitrate plant, which will cost approximately $3,000,000. It is said the works will specialize in the manufacture of nitric acid and ammonia.

California

BERKELEY.—The Philadelphia Quartz Company is making rapid progress in the construction of its new plant at Fifth and Grayson Streets, and is planning to inaugurate operations at an early date. The company proposes to manufacture silicate of soda in its various forms. Alfred C. Elkington is president.

LOS ANGELES.—The Ventura Refining Company is building a new plant at Fillmore for the refining of oil and the manu-

facture of wax extracted from oil. The new works represent an investment of $300,000. F. E. Snowden is manager.

LOS ANGELES.—The Damon Specialty Company, manufacturer of polishing products, is planning for the construction of a new reinforced-concrete plant to cost about $35,000.

LOS ANGELES.—The R. W. Pridham Company, 903 North Main Street, manufacturer of paper boxes, will build a two-story brick addition to its plant, about 92 x 98 ft.

LOS ANGELES.—The California Burdett Oxygen Company will build a new one-story shop, about 57 x 61 ft., on Fifty-second Street, near Santa Fe Avenue.

MARTINEZ.—The Butters Syndicate, which recently acquired the plant of the Peyton Chemical Company, is making rapid progress in the construction of its new plant for the manufacture of chemicals, and expects to inaugurate operations within the next three months.

PIEDRA.—The Piedra Magnesite Company is making rapid progress in the erection of its new magnesite calcining plant. The magnesite reduction kiln has been completed, and the installation of the machinery in the new works will soon commence.

Colorado

DENVER.—The International Rubber Company, 1569 Broadway, is taking bids for the erection of a new four-story building, about 125 x 145 ft., at 999 South Acoma Street, to cost about $100,000. Walter L. Rice, 1608 Broadway, is the architect.

Connecticut

BRIDGEPORT.—The Heppenstall Forge Company, 95 Howard Avenue, is building a new one-story addition to its plant, about 60 x 361 ft. The structure will cost about $10,000.

BRIDGEPORT.—The Spring Perch Company, manufacturer of coach springs, is completing the erection of a new one-story plant, 130 x 360 ft., at Stratford. The new works will represent an investment of about $100,000.

NEWINGTON.—P. Garvan, Inc., Bartholomew Avenue, has commenced the construction of a new two-story paper mill, about 75 x 147 ft., at Elmwood, near Newington, to cost $50,000.

STAMFORD.—Baer Brothers, Canal Street, manufacturers of paints, bronze powders, etc., have commenced the construction of an addition to their plant to replace portion of works recently destroyed by fire.

WATERBURY.—The Waterbury Manufacturing Company is building a new six-story addition to its plant to be devoted to the manufacture of brass goods. The structure will cost $100,000.

Delaware

WILMINGTON.—The Jessup & Moore Paper Company has commenced the construction of a new two-story reinforced-concrete and brick addition to its plant, about 40 x 150 ft., to cost $30,000.

WILMINGTON. The Electric Hose & Rubber Company, Twenty-first Street, is planning for improvements in its plant to cost $20,000.

WILMINGTON. The Pusey & Jones Company, Poplar Street, is said to be considering the construction of a new foundry addition to its plant to cost about $75,000.

Florida

PENSACOLA.—The Pensacola Fertilizer & Oil Company is planning for the installation of new machinery in its local plant for the manufacture of oil and fertilizer from menhaden. F. W. Miller is president.

Illinois

CHICAGO.—Swift & Company is having plans prepared for the construction of a large fertilizer plant at Hammond, to cost about $500,000. Charles H. Kane is engineer for the company.

CHICAGO.—The Octigan Drop Forge Company has had plans prepared for the erection of a new one-story machine shop, 50 x 100 ft., at its plant on Lowe Avenue.

CHICAGO.—The Ehman Tire & Rubber Company, 144 West Twenty-seventh Street, has had revised plans prepared for the construction of a three-story and basement brick addition to its plant to cost about $50,000. Dibelka, Flaks & Minchin, 130 North Fifth Avenue, are architects.

CENTRALIA.—The Centralia Envelope Company is making rapid progress in the construction of its new manufacturing plant and power house. When completed the works will cost $75,000.

EAST ST. LOUIS.—The East St. Louis Cottonseed Oil Company is having plans prepared for the construction of a new two-story addition, about 500 x 700 ft.

JOLIET.—The Standard Paint Company has commenced the erection of a new roofing and paint manufacturing plant to cost $500,000. Hanson & Peterson, South Desplaines Street, has the contract for construction.

Kansas

KANSAS CITY.—The Wyandotte County Gas Company is planning for extensive improvements and additions in its local plant, to include the installation of new machinery, laying of pipe lines and construction of pumping stations.

Kentucky

LOUISVILLE.—The Federal Chemical Company has had plans prepared for the erection of a new plant at Columbus, Ohio, adjoining its mixing works. The new factory will be devoted to the manufacture of sulphuric acid, and is estimated to cost $300,000.

Louisiana

HARVEY.—Swift & Company have commenced the construction of a new local acid plant, comprising three buildings. The structures will be brick, stone and reinforced-concrete, and are estimated to cost $200,000.

Maryland

BALTIMORE.—The Chemical Figments Company, President Street, is planning for the installation of new machinery at its works, including electrical equipment.

BALTIMORE.—The Hess Steel Company is planning for the erection of an addition to its electric furnace on East Biddle Street at Loneys Lane.

BALTIMORE.—The Standard Oil Company has had plans prepared for the erection of a new addition, five-story, about 38 x 130 ft., to its plant at Pratt and Penn Streets.

Massachusetts

BOSTON.—The American Agricultural Chemical Company has commenced the construction of a new one-story addition to its chemical plant at Portsmouth, N. H. Harry A. George, 92 State Street, Boston, is engineer.

WATERTOWN.—The United States Government has commenced the erection of its new foundry at the local arsenal. The structure will be brick, about 280 x 300 ft., and is estimated to cost about $500,000.

Michigan

GRAND RAPIDS.—The Imperial Chemical Company has acquired the business of the Superior Laboratories Company, and will take over the plant and equip for the manufacture of an anti-rust preparation for stoves. The company is also planning to increase its capital stock.

DETROIT.—The McCord Manufacturing Company, manufacturer of railway specialties, has commenced the construction of a new one-story machine shop, about 40 x 80 ft., at its works on East Grand Boulevard.

MANISTIQUE.—The Manistique Pulp & Paper Company is building a new one and two-story paper and pulp mill, 20 x 36 ft., and 60 x 200 ft., respectively, at a cost of $1,000,000. W. J. Murphy, Minneapolis Tribune, 57 South Fourth Street, Minneapolis, Minn., is president.

Minnesota

MINNEAPOLIS.—The Federal Steel & Machinery Company, Metropolitan Building, has awarded a contract to John Brickels, Waseca, Minn., for the erection of three machine shops, about 110 x 400 ft., and a two-story foundry, about 100 x 215 ft. F. E. McClure is manager.

Missouri

ST. LOUIS.—The Tri-City Steel Company, incorporated under Delaware laws with a capital of $1,000,000, has completed negotiations for the purchase of eight and one-half acres of property in the industrial section of the city, and is planning for the immediate erection of a rolling mill and auxiliary structures to cost about $100,000, which will be devoted to the manufacture of steel railroad ties, rail joints and other supplies.

Montana

BUTTE.—The Anaconda Copper Mining Company has acquired the interests of the Montana-Canadian Oil Company and is planning for extensive development of the gas fields at Sweet Grass. The company is also planning to construct pipe lines to Great Falls, Helena and Anaconda, the gas being used for lighting and heating purposes in the smelters at Anaconda and Great Falls. It is said that the entire work will cost between $10,000,000 and $15,000,000. C. F. Kelley heads the company.

New Hampshire

BERLIN.—The International Paper Company, 30 Broad Street, has commenced the construction of a new one-story filtration plant, about 30 x 40 ft., at its works. The structure will cost $15,000. The H. P. Cummings Construction Company, Ware, Mass., is the contractor.

New Jersey

JERSEY CITY.—William T. Baker, Inc., manufacturer of varnishes, etc., has awarded a contract for the erection of a new one-story reinforced-concrete factory building on Suydam Avenue, near Communipaw Avenue.

NEWARK.—The Union Smelting & Refining Company, Avenue D and Fourteenth Street, New York, is making rapid progress in the construction of its new plant on St. Charles Street. The entire works will cover about five acres of land, and are estimated to cost $500,000. L. D. Waixel is president.

NEWARK.—The Barlow Foundry Company has had plans prepared for the erection of a large addition, about 59 x 100 ft., to its works in Hunter Street, near New Jersey Railroad Avenue, to cost about $20,000.

NEWARK.—The United Color & Pigment Company has taken bids for the erection of a new manufacturing plant on Evergreen Avenue. Percy B. Taylor, Essex Building, is architect and engineer.

NEWARK.—The Butterworth-Judson Company, manufacturer of chemicals, has taken out a building permit for the erection of a new one-story addition to its plant on Avenue R, to cost about $10,000.

IRVINGTON.—The Irvington Insulator & Varnish Works, Tremont Avenue, have had plans prepared for the construction of a new one-story factory, about 100 x 200 ft., to cost $25,000. The D. A. Hopper Company, Union Building, Newark, is architect.

LINDEN.—Fire recently destroyed the plant of the Transatlantic Chemical Company, Elizabeth Avenue and Stiles Street, with loss estimated at $50,000.

KEYPORT.—The Reliance Rubber Company has completed alterations and improvements in its factory on Manchester Avenue, and inaugurated operations for the manufacture of rubber sundries. The company was formerly located at Hoboken.

PERTH AMBOY.—A new one-story power plant, 60 x 70 ft., will be erected by the American Smelting & Refining Company at its Maurer works. Headquarters of the company are at 120 Broadway, New York.

GLASSBORO.—The Owen Glass Company is rapidly completing its new plant, which has been in course of construction for the past year, and is planning to inaugurate operations within a few months. The entire works have cost approximately $1,000,000.

TRENTON.—The Empire Tire & Rubber Company has commenced the erection of a new one-story brick and steel factory, about 90 x 320 ft., to cost $40,000. W. A. K. Bugbee & Company, 206 East Hanover Street, is the contractor.

New York

NEW YORK.—The Linde Air Products Company, 30 East Forty-second Street, has acquired a site at Norfolk, Va., and is planning for the erection of a new plant for the manufacture of oxygen and other air products for industrial service.

LONG ISLAND CITY.—The Continental Varnish Company has filed plans for the construction of a new plant at Varick Avenue and Ingraham Street, on property about 200 x 275 ft., recently acquired. The works will cost $60,000.

COLLEGE POINT.—Fire, Oct. 13, destroyed the plant of the British-American Chemical Company, on Third Avenue and Flushing Bay, with loss estimated at $250,000.

ROCHESTER.—The Eastman Kodak Company, 343 State Street, has awarded a contract for the construction of a one-story paper burning mill, about 40 x 75 ft., at Kodak Park. A. Friederichson & Sons Company, 710 Lake Avenue, is the contractor.

SYRACUSE.—The Penman Littlehales Chemical Company, Spring Street, has had plans prepared for the erection of an addition and improvements to its plant to cost about $25,000.

BUFFALO. — The Greater American Chemical Company has awarded a contract to the Peckham Construction Company, Mutual Life Building, for the erection of a new two-story reinforced concrete factory, about 30 x 60 ft., at Colgate Street and South Park Road.

North Carolina

GOLDSBORO.—Fire, October 14, destroyed the entire plant of the Southern Cotton Oil Company, with loss estimated at $300,000.

Ohio

BARBERTON.—The Semi-Steel Foundry Company has commenced the erection of a new foundry and machine shop at its plant. The structures will be of brick, steel and concrete, and will cost $150,000.

BUCYRUS.—The American Clay Manufacturing Company has perfected arrangements for increasing the capacity of its plant, and is planning for the erection of a new grey iron foundry and steel plant.

MASSILON.—The Massilon Steel Castings Company, recently organized, has commenced the erection of a new plant, the main building of which will be of brick and steel, about 100 x 100 ft.

WESTERVILLE.—The Culver Superior Glass Company is planning for the erection of a large plant for the manufacture of automobile lenses, watch crystals, mirrors and other glass products. W. D. Shaw of Columbus is president.

YOUNGSTOWN.—The National Carbon Company, Inc., the Union Carbide Company, the Linde Air Products Company, and the Presto-O-Lite Company, have been merged into one company for the manufacture of calcium carbide and all gas-producing materials and gas, machinery for gas production, lighting carbons, electric batteries and kindred products.

Oklahoma

PICHER.—The Fort Worth Lead & Zinc Company has commenced the erection of a new concentrating plant which will have a capacity of approximately 200 tons per shift. Two shafts are now being sunk, and an ore body of about thirty-five feet thick was shown by preliminary drilling.

Pennsylvania

PHILADELPHIA.—The Penn Chemical Company, 1232 Washington Avenue, has commenced the construction of a new one-story addition to its plant, about 25 x 45 ft., to cost $25,000.

PHILADELPHIA.—The Tioga Steel & Iron Company has acquired five acres of land near its factory at Fifty-first Street and Grays Avenue, and is planning for the erection of a large plant for the manufacture of guns for the government.

PHILADELPHIA. — Baxter, Kelly & Faust have awarded a contract for the construction of a one-story brick lime house at C and Tioga Streets. The Fred A. Havens Company, Philadelphia, is the contractor.

CHESTER.—Fire recently destroyed a portion of the plant of the Sun Oil Company, with loss estimated at $60,000.

CHELTENHAM.—Hoffman, DeWitt & McDonough Company, Inc., manufacturer of chemicals, etc., has awarded a contract to the William Linker Company, 831 Cherry Street, Philadelphia, for the erection of a new boiler house, calender room and mill.

YORK.—The Cochran Brass Foundry Company, East Wallace & Sherman Streets, has awarded a contract to A. M. Hake & Company, York, for the erection of a large addition to its plant. The company has received a large order from the Government for castings for submarine service.

KANE.—Fire recently destroyed a portion of the plant of the Keller Chemical Company, Ltd., with loss estimated at $100,000. Headquarters of the company are at Wetmore.

PITTSBURGH.—The American Sheet & Tin Plate Company is making extensive improvements to its plant at Leechburg.

Rhode Island

PROVIDENCE.—John D. Lewis, manufacturer of chemicals, dyes, etc., is planning for the establishment of a new branch in the Drexel Building Philadelphia, Pa. George A. Street of Philadelphia will be in charge of the new office.

Texas

HOUSTON. The new plant of the Petroleum Refining Company on the Ship Channel is being rushed to completion as rapidly as possible. Workmen are busy in day and night shifts, and it is expected to complete the works within the next month. When completed, the plant will include a concrete steam plant, machine shop, carpenter shop, and auxiliary structures.

HOUSTON.—Fire recently destroyed the plant of the Wortham Bag & Fiber Company, 501 Washington Avenue, with loss estimated at $100,000. It is said the works will be immediately rebuilt.

Washington

SEATTLE.—The Aurora Foundry Company has inaugurated operations in its new plant on tract 6 of the Port Commission's Canal Waterway. The company will specialize in the manufacture of steel castings.

TACOMA.—The Bilrowe Alloys Company is planning to double the capacity of its plant to provide for increased demands. The company will also make extensive improvements in its furnaces.

West Virginia

BRAMWELL. — The National Carbide Company has awarded a contract to Westinghouse, Church, Kerr Company, 37 Wall Street, New York, for the erection of a new chemical plant to cost $500,000.

HUNTINGTON.—The Virginian Potteries Company, 528 Fourth Street, have had plans prepared for the erection of a new factory, about 132 x 408 ft., to be devoted to the manufacture of electric insulators. The structure will cost about $35,000.

Wisconsin

CUDAHY.—The Federal Rubber Company has awarded a contract for the erection of a new six-story addition, about 45 x 300 ft., to its plant, to provide for increased capacity.

MILWAUKEE. — The Globe Seamless Tube Company, Thirty-fifth and Burnham Streets, has commenced the erection of a new one-story addition, about 48 x 50 ft., to its plant, to cost about $7,000.

MENASHA.—The Edgewater Paper Company is making rapid progress in the construction of a new one-story addition to its plant, about 48 x 150 ft. The structure will cost $9,000. C. R. Mayer & Son, Oshkosh, are the architects.

Manufacturers' Notes

THE VALLEY STEEL COMPANY, St. Louis, Mo., has in operation a Baily Electric Furnace for heat treating car axles.

THE MERRILL METALLURGICAL CO., San Francisco, Cal., has been appointed Pacific Coast representative of the Jonathan Bartley Crucible Co. of Trenton, N. J.

NAVY BUYS ELECTRIC FURNACES.—The Navy has placed contracts for seven more six-ton electrical furnaces, making 11 purchased recently. Each calls for $50,000, approximately, or a total payment of $550,000. They will be installed at government's Charleston, W. Va., plant, three at Watertown arsenal and one at Washington Navy Yard.

MR. LOUIS WILPUTTE announces that he has resigned the presidency of the Otto Coking Company, Inc., and has formed with American capital exclusively the Wilputte Coke Oven Corporation, retaining the entire organization formerly operated by the Otto company. Offices will be maintained for the present at No. 6 Church Street, New York.

THE AMERICAN PULVERIZER COMPANY has moved its office and factory from East St. Louis, Ill., to St. Louis, Mo., in order to provide larger quarters and improved facilities for handling its business.

THE PFAUDLER CO., Rochester, N. Y., has established the following branch offices: Pittsburgh, Pa., 1502 Oliver Building., Mr. James H. Charity, representative; Detroit, Mich., 1946 Penobscot Building, Mr. George M. Scott, representative.

WESTINGHOUSE ELECTRIC & MFG. COMPANY ANNOUNCES WAGE INCREASE.—Another increase in wages for shop employees aggregating nearly $2,000,000 a year has just been announced by the Westinghouse Electric & Manufacturing Company. Effective October 16, all employees observing shop hours, except munition workers, will receive an additional bonus of 10 per cent if they are on a salary or time-rate basis, and of 7 per cent if they are on a piece, premium or task basis. The company has 20,000 employees.

PHILADELPHIA BRANCH. — Marden, Orth & Hastings Corporation have recently opened a new branch in the Widener Building, Philadelphia. The branch is in charge of Mr. J. Raymond Murphy, who has had a very wide acquaintance with the trade in the Philadelphia district.

THE ELECTRIC FURNACE CONSTRUCTION CO., 1304 Finance Building, Philadelphia, makes the following announcement of contracts closed for Greaves-Etchells electric furnaces:

Steel Corporation of South Africa—Two five-ton furnaces.

Sociedad Espanola de Construction Naval Madrid—Two ten and one six-ton furnaces.

Singer Manufacturing Co., New York—One six-ton furnace.

A furnace of two tons capacity was recently started up at Messrs. Kayser Ellison & Co., Sheffield, on special aeroplane steels and twenty-eight heats of sound steel were obtained from cold new furnace started Monday noon to Friday evening. The firm reported the furnace could have been worked quicker, but the men were not accustomed to such rapid melting with a new furnace.

The company announces that Mr. Frank W. Brooke, who was originally connected with the Gronwall Dixon furnace at Detroit and latterly as metallurgist for the Ludlam Steel Works and the Ludlam Electric Furnace Co., is joining their staff as director. Mr. Brooke will be responsible for the construction and running of the Greaves-Etchells furnaces. He will be assisted in the erection and installation by Mr. G. W. Ketter, B. Sc., who has installed a great many of the electric furnaces now running and who has just completed the installation of ten furnaces for the British Forgings Co., Toronto.

THE LOCOMOTIVE PULVERIZED FUEL CO., 30 Church Street, New York, announces that the Milwaukee Electric Railway & Light Company have recently placed with this company an order to equip with our apparatus for the burning of pulverized fuel 25,000 hp. of boilers at their Oneida Street plant.

This is the first central station plant to be so equipped, and the largest amount of boiler horsepower that has yet been equipped with powdered coal.

THE CONTINUOUS ZINC FURNACE CO., Hartford, Conn., which developed at its plant on Broad Street the "Johnson" process of electric smelting zinc-lead ores, saving all the values in zinc, copper, lead, gold and silver, has sold the major right, title and interest in this process to the American Smelting & Refining Company, the largest interest in the lead and silver business in the world. This company will exploit the process, carry along a commercial test and build a commercial furnace at one of its Western plants.

Manufacturers' Catalogs

THE INDUSTRIAL ELECTRIC FURNACE COMPANY, Chicago, Ill., has just published a new bulletin, No. 40, October, 1917, describing up-to-date facts on electric furnace for the melting and refining of ferrous and non-ferrous metals, giving photographs and diagrams.

JONATHAN BARTLEY CRUCIBLE CO., Trenton, N. J., has just issued a new catalog showing various types and sizes of graphite crucibles and specials used in foundry practice.

THE AMERICAN STEEL EXPORT COMPANY, New York City, has issued a new twenty-four page pamphlet giving the groups of countries and lists of materials affected by the President's proclamation and subsequent orders together with facsimiles of forms prescribed and an explanation of their use.

THE ARMSTRONG CORK & INSULATION COMPANY, Pittsburgh, Pa., has issued a little pamphlet on "Nonpareil Insulating Brick for Boiler Settings."

THE UNITED STATES SILICA COMPANY has issued a booklet describing "Flint-Shotting," a form of sand blasting. The booklet is called "Little Journeys of the Flint Shot Man." The company's headquarters are in Chicago, Ill.

KAESTNER & HECHT CO., Chicago, Ill., has issued a book entitled "Paint Machinery."

THE GOLDSCHMIDT THERMIT COMPANY, New York City, has issued Pamphlet No. 20, third edition, describing thermit carbon-free metals.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, New York City, has issued the following: Bulletin No. S-112, illustrating and describing Snow oil pumps; Bulletin No. W-500, describing pot valve pressure pumps; and Bulletin W-308, covering "Duplex" piston pattern pumps.

THE LINK-BELT COMPANY, Chicago, Ill., has issued Folder No. 340 describing the sand and gravel washery at the Raritan Ridge Clay Comany, and Book No. 343, on rope tramway system, and Book No. 322, "Tipple at Powhatan in Pocahontas Field."

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Potash, I. W. W., and the Fuel Administration

The sand hills of Nebraska are capable of supplying our most urgent needs for potash. Energetic Nebraskans have supplied the capital and plants and are now ready to turn out the salt. But these potentialities bid fair to be wasted through the attentions of traitorous I. W. W. and a corresponding inattention of various branches of officialdom.

Near Alliance, four evaporating plants aggregating over 5000 boiler horse power are evaporating nearly 10,000,000 lb. of brackish lake water daily, producing every 24 hours something like 350 tons of salts containing approximately 25 per cent of water-soluble potassium oxide. This production figures up to the rate of 32,000 tons of K_2O per annum. But even this most credible showing is a long way from the needs of the United States, which amounts to about 275,000 tons.

The speed and energy with which this production has been developed may be appreciated when it is known that the present output is approximately ten times the production of this district for the year 1916, and over thirty times the production of the entire United States during 1915. One plant, whose present output of potash is nearly one-fifth that of the region, started construction on Aug. 15, 1916, and shipped three carloads the latter part of November—100 days later.

Not only energy and resourcefulness on the part of the engineers has been required, but a great amount of courage has been evidenced by the capital invested. The production of potash from these fields would have been precarious before the war, and, for that matter, will be after the war if the American companies feel the effect of an unrestricted German trade-war. This may easily be demonstrated by the following approximation of the present cost of a ton of K_2O as produced in Nebraska.

4½ tons of coal at $3.00 per ton	$13.50
200 gal. of fuel oil at 8c. per gallon	16.00
22 hours' labor at 30c. per hour	6.60
Material for repairs and renewals	4.00

Total cost at Alliance, Neb.....$40.10 per ton K_2O

This allows nothing for interest, amortization or profit, nor for royalties, which latter may amount to 20 per cent. Compare the probable cost of this potash to the American user with the cost of German material, remembering that the Schmidtman mines have contracted for 50 per cent K_2O muriate at $15.00 per ton and Kainite (12 per cent K_2O) at $2.00 per ton, even though the price of the former product was about $32.75, f.o.b American ports during 1912 to 1914.

The possibility of successfully meeting the cut-throat competition of the Huns rests mostly upon factors beyond the control of the operating companies. For instance, it would undoubtedly be good practice to fire powdered coal exclusively, thus eliminating the costly though handy fuel oil. A plant thus operated should have been able to produce potash six months ago at an operating cost less than half that estimated above. But the incentive to such improvements is now largely lost since the fuel administration forced the potash producers to give up their contracts with coal companies for ample fuel at 40 cents a ton (and which the coal companies were apparently glad to sign) and substitute therefor fluctuating supplies of the same commodity at a two-dollar advance.

Again, such improvements are almost out of the question on account of the execrable deliveries on materials now ruling. At the present time there is at least 3500 additional horsepower in plant capacity under construction or contract, which should increase the total production of this district about 80 per cent. Yet the deliveries on this material are so slow that no large increase in Nebraska is expected before the summer of 1918.

During a visit of inspection early in November, the largest plant was found completely shut down on account of "no coal," while the next largest producer was practically idle in an effort to eliminate American traitors from his organization. Nearly 70 per cent of the total output was thus suspended.

To produce potash, the Nebraska operators absolutely need three things: first, plant protection; second, ample coal, and third, adequate fuel-oil.

In the first case the I. W. W. have descended upon these mushroom communities—evidently they are better informed as to these strategic points for operation than the governmental agencies who should be rounding them up for summary war-time justice. Second, the coal situation is aggravating in the extreme—only another instance of how exorbitant prices fail to stimulate supplies. Third, the Standard Oil Company has just notified the potash producers that they would be unable to ship further supplies of fuel-oil.

Leaving the labor situation aside for the moment, urgent as it is, it does seem that the other factors should receive attention from some national authority. For the production of potash is unquestionably a national necessity. Among the multitude of committees, subcommittees and boards now operating at Washington, there should be some committee on chemicals which recognizes the urgency of this matter, and with authority to bring the fuel administration, transportation board and priorities committee to the place where they will arrange for a continuous and ample supply of fuel to this industry. The price is not in question—but a sufficient supply is absolutely essential.

A School of Mines Debauched

Colorado is being treated to an experience the like of which seldom if ever has been forced upon a sovereign State. She has been compelled to sit aside and watch the slow but certain disintegration of her School of Mines, due to the ignorance and unfitness of a majority of the school's trustees who are charged with its welfare. This is a matter of more than local concern, for the institution has had an honorable career, and its graduates have played an important part in the mining industry of the United States and foreign countries. For them the recent fiasco at their *alma mater* is a source of the deepest regret.

Beginning last spring, when the trustees refused to support the president and faculty in the discipline of students guilty of drunkenness, rowdyism, and assault on an instructor, there has been a succession of incidents calculated to undermine efficiency and impair the reputation of the school. At that time honor was subordinated to the dollar mark, and principle was abandoned for expediency. Trustees ignorant of their official function, and wholly lacking in appreciation of the ethics of the situation, forced their personal wishes in spite of public and private protest. The president was dismissed, the faculty humiliated, and the students' outrageous conduct upheld.

Confronted then with the problem of finding a new head for the school, the trustees early discovered that no self-respecting and able educator and engineer would accept the position. The opening day of the present session was rapidly approaching, with no willing candidate in sight, when finally, in sheer desperation at their inability to induce a competent man to take the place, the majority of the board committed the astounding blunder of offering it to a former incumbent who had been removed four years previously after charges of a disreputable nature had been made and substantiated. Despite the renewal and proof of charges of unfitness, and against the protests of alumni and friends of the school, the infamous deal was consummated, to the discredit of the State and one of its institutions.

The opposition to this action on the part of an unfit majority of the board was vigorous and determined. Alumni sought to prevent the debauchery of their *alma mater* by instituting suits to restrain the trustees and oust the president. Thus the matter dragged its slimy length through the courts and paraded its shady details in the local press, to the discredit of the institution and its responsible officials. The end is not yet, though it is doubtful if further attempts will be successful in changing the situation. The net result is that Golden stands discredited, with a president in disrepute, and a board of trustees the majority of whom are held in utter contempt.

The trouble in Colorado is fundamental, and the solution of the problem must be found beneath the surface of the teapot tempest in which the school's affairs have been embroiled. The management of the institution is vested by statute in a board of five trustees appointed by the Governor of the State. This is the beginning of the trouble, for executives have not exercised care to appoint men of large mental caliber. There has been too much yielding to political pressure and silly sentiment. In times past, political parties have sought preferment in the appointment of school

employees, and trustees have perverted their official positions to the attainment of personal ends.

A solution lies in complete reorganization by appropriate legislative action. The logical step is to abolish the board of trustees, combine the school with the State University, and administer its affairs through the regents and faculty of the latter institution. If this is not sufficient, let the school be removed bodily to the university, and thus avoid the pernicious meddling by small-town cliques. There would be economy of dollars and effort in such a consolidation, and a breaking away from some of the evil traditions that have grown strong in recent years. Such a move would be distasteful to older alumni, who dislike to see anything done to destroy the identity of the Colorado School of Mines, but even they probably would concede the wisdom of making some change to wipe out effectually and forever the present undesirable conditions.

A Controlled Iron and Steel Market

The iron and steel market is now under practically complete control of the Government. An initial batch of prices, to serve as a basis for the whole price structure, was announced at Washington Sept. 24. A second batch was announced Oct. 11 and a third batch, practically completing the price-fixing program, was announced Nov. 5.

The control of prices, except in the case of coke, which is fixed by the President by authority of the Lever act, occurs through agreement between the War Industries Board and the leading producers, the price announcements being made by the President upon recommendation of the board. To an extent the agreed prices represent compromises, but in general the compromises were effected by the War Industries Board bringing the manufacturers to its viewpoint, acquiescence in the specific prices being then readily granted.

Very fittingly, the details as to analyses, extras, differentials, etc., are left to committees of the American Iron and Steel Institute. The work can thus be done much better than by Washington agencies and there is the telling advantage that the regulations have a very friendly aspect. The industry is put upon honor and it is fully capable of carrying out the spirit of the arrangement.

Price setting, however, is but one feature of control. Through the priority authorities the sequence in which orders shall be filled is prescribed and thus complete control is assured.

The whole transformation has occurred with a smoothness and quickness that many did not anticipate, and yet it is all very simple. The Washington authorities required certain things, for the best conduct of the war, and did not insist upon more than was necessary. The full co-operation of the iron and steel trade was counted upon to supply the details and make the operation easy. That hearty co-operation is usually ascribed to what is known as the virtue of patriotism. It is very difficult, however, to assume "patriotism" as a dissociated virtue, and analyze it. It is really largely an outgrowth of intelligence, vision and unselfishness.

At this crisis in the world's affairs an American who has vision and intelligence cannot possibly be selfish. If the iron and steel producers exhibit at this time what is called patriotism it is simply that they have intelligence and vision. They deserve no particular credit for having these qualities at this time, because that is a matter that was settled by other circumstances. The nature of the industry is such that only men of intelligence and vision remain in it. Others stay out, or if they chance to get in are shortly eliminated through being unable to maintain the pace.

The price structure that has been built up in a period of a few weeks is, from present viewpoints at least, a harmonious and well-proportioned one. The relations between material in its successive stages from crude material to finished product seem to distribute profits with a fair degree of equity.

The iron and steel market existing just prior to the inception of price-fixing was a declining one. The top had been reached in June. The declines in the interim had been slight, but they were sufficient to show the trend quite clearly. Eventually much lower prices would have come to rule, through the play of open market forces, but the declines would have been irregular, and least in the commodities most needed by the Government. The Government, in any event, could not wait, time being a vital element in war.

The prices are on the "one price for all" principle enunciated so clearly by President Wilson in his appeal of July 12.

Although the "one price for all" doctrine seemed to be clearly enunciated by the President last July there has been some misunderstanding, now quite largely dispelled. There were some who appeared to conclude that one price for all meant all, passing down the line from the producer to the distributor. They said that was impractical. Of course it was, so impractical that no one should have supposed that was meant. What was meant was that there should be one price, applicable alike in sales to the Government, in sales to the Government's allies, and in sales to those to whom the producers sold. The merchant, the "jobber," would buy as formerly, and sell at a suitable advance. If a steel producer conducts a jobbing or "store" business, as some do, it is a separate enterprise. When the first steel prices were announced there were some buyers who complained that the mills were not carrying out their agreement "to sell," because they stated they could not make the deliveries desired. The essence of the agreement, however, was really that when the mills should sell they would sell at not above the prescribed prices.

It is of value to note how the criticism and misunderstandings of only a few weeks ago have disappeared. Difficulties that may develop in future may disappear in like manner. The control is in comparatively smooth operation already, despite the shortness of the time and the intricacies of the case.

Readers' Views and Comments

Saving Sulphur in Sulphite Mills

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of October 15th, page 457, second column, 4th paragraph, you credit me with the statement that the Canadian consumption of sulphur is 300 pounds per ton of sulphite pulp produced, whereas the American consumption is only 250. This statement is slightly incorrect. American mills to-day are using from 250 to 450 pounds of sulphur per ton of sulphite produced. In a few isolated instances the consumption is less than 250 pounds. Canadian practice is equally as good as that in the United States. The point I wished to make was that there was room for improvement in the sulphur burning practice of nearly all sulphite pulp mills, whether in Canada or in the United States, and that improved practice would result in a material saving of sulphur.

ALFRED W. G. WILSON.

Department of Mines.
Ottawa, Canada

Naphthalene

To the Editor of Metallurgical & Chemical Engineering

SIR:—Trouble is sometimes caused in buying naphthalene, which is occasioned by the ignorance of the buyer. We have known cases where naphthalene flake and balls with a melting point of 79 deg. C. have been sold as moth preparations. This is wrong. Only flakes or balls having a melting point of 80 deg. C. should be used for this purpose, in other words, the flake and balls should not only be white when made, but should hold this color when exposed to the light and air.

We have also known of brokers and buyers who are not posted selling a low grade of flake to manufacturers for chlorinating, when a very high grade of flake must be used for such purposes. A 79 deg. C. melting point flake is very suitable for most dye stuffs, providing it contains no anthracene and does not contain any petroleum or other impurities foreign to a straight coal tar product. Providing it does contain such impurities, it would show up in the sulphonating or nitration and would be a serious objection for dyestuffs.

F. H. B

The Western Metallurgical Field

United States Production of Spelter

Figures compiled by C. E. Siebenthal, of the United States Geological Survey, Department of the Interior, from reports submitted by all zinc smelters operating during the first six months of 1917 show that the production of spelter from domestic ore in that period was 311,539 short tons and from foreign ore 49,599 short tons, a total production of 361,138 tons, compared with 351,004 tons for the last half of 1916 and 316,452 tons for the first half.

The output of spelter by Illinois smelters increased about 4000 tons for the six-months period, and that of Oklahoma over 14,000 tons, but the production of Kansas fell off nearly 25,000 tons as a result of the declining price of spelter combined with the high cost of natural gas and other fuel. The remaining spelter-producing States made a large gain, especially Pennsylvania. The output of primary electrolytic spelter also made a good gain.

The number of retorts at zinc smelters at the close of 1916 was 219,418, and there were then building or planned 13,632 additional retorts, a total of 233,050. The number at smelters June 30, 1917, was 232,202, and about 15,000 additional retorts were building or planned a total of over 247,000 retorts.

Owing to the low price of spelter at the close of the first half of 1917, many smelters were idle, either wholly or in part. More than 35,000 retorts were idle June 30, 1917, and this number does not include retorts engaged in refining prime Western spelter or in redistilling zinc ashes and skimmings. Fourteen plants were wholly idle.

Electrolytic Zinc in Utah

The process used by the Judge Mining & Smelting Co., Park City, Utah, for the production of electrolytic zinc, is briefly outlined by Mr. C. A. HANSEN in the recent annual report of the company. The zinc concentrates produced at the company's concentrator contain some lead and silver. They are treated first in a Wedge roasting furnace. The roasted ore is then leached by agitation with an eight per cent sulphuric acid solution in Deveroux tanks. The leach-tank product is discharged to classifiers for the removal of the coarse insoluble material. The solution and fine suspended solids which flow from the classifier are treated in a Dorr thickener, the underflow from which is sent to an Oliver filter. The coarse and fine solids thus recovered from the classifier and filter are sold to lead smelters for the recovery of lead and silver.

The leach liquor contains impurities in the form of copper and cadmium which are dissolved from the ore, and these are removed before the zinc is recovered. The removal of impurities is accomplished by passing the liquor through tube mills filled with zinc shot on which the copper and other metals are precipitated in spongy form. The solution flowing from the tube-mills is filtered and is then ready for treatment in the electrolytic cells.

The cell room, a view of which is shown in the accompanying illustration, contains 120 cells arranged in two groups of 60 each. Each group is served by a gener-

FIG. 1. CELL ROOM, JUDGE ELECTROLYTIC ZINC PLANT

ator delivering 5000 amperes at 250 volts. Each cell carries 12 aluminum discs, five feet diameter, mounted on a rotating shaft. Alternating with the aluminum cathodes are 13 lead anodes which are supported independently of the shaft. Zinc is deposited on the rotating cathodes, and in the course of about three weeks each cell of 12 discs collects about 5000 lb. zinc. The loaded shaft is removed, the zinc stripped, and the shaft reassembled for return to the cell. The electrolytic zinc is melted, cast into cakes and marketed. The electrolyte is again used in leaching roasted ore.

The Jay Bird Mill, Century, Oklahoma

The extent to which Joplin milling methods have been adopted in the new Miami district, Oklahoma, is indicated in the following description of the Jay Bird mill of the Commerce Mining & Royalty Co., kindly furnished by Mr. W. M. GARRED, superintendent. The Miami district is more fortunate than Joplin in that the grade of ore is higher, and there is every hope of weathering any reasonable slump in concentrate prices such as has harrassed Joplin operators for some time past.

At the Jay Bird mill, a flow-sheet of which is shown in the accompanying sketch, the ore is dumped on a 5-in. grizzly where chunks of barren country rock are hand-picked and the balance sledged through, falling into the 200-ton-mill hopper. From here the material passes through a 16-in. jaw crusher (Rogers, Joplin type) set at about 1½ in. opening. Without intermediate screening the crushed ore is run through 36-in. rolls set immediately below and in front of the crusher. The broken dirt is then raised in elevator (1) fitted with buckets 7 in. by 20 in., and screened through a ⅜-in. trommel 4 ft. diameter and 8 ft. long.

The ⅜-in. undersize goes to a 6-compartment rougher jig, a large Cooley machine of the fixed-sieve type. Since the feed is unclassified, a bed of coarse particles several inches deep is formed on the grates by the pulsating water, the bed acting as a screen. The downward suction of the water draws the fine mineral into the hutch, from which it is discharged to the "smittem" elevator and thence to the cleaner jig. The bed products of the first two compartments are drawn off as coarse concentrates, while the bed products of the last four compartments join the oversize of the ⅜-in. screen. This oversize passes through one of a pair of 30-in. rolls, is elevated (2) and screened through a 5/16-in. trommel, 4 ft. diameter and 8 ft. long. The oversize is crushed in 36-in. rolls and returned to elevator (2).

The 5/16 in. undersize is fed to a "regrind" jig of six compartments, the tailings from which are wasted. No bed product is made and the hutch products join those of the rougher jig in the smittem elevator (3), and are charged as feed to the 6-compartment cleaner jig without further crushing. The first five hutch products and the first three bed products from this machine are finished concentrates. All tailings are crushed in 30-in. rolls, elevated in "chat" elevator (4) and screened through a ⅛-in. trommel. The oversize from this is returned to the circuit. The ⅛-in. undersize is fed to a 4-compartment sand jig, where concentrates are drawn from the hutches. The jig tailing is settled in a pair of

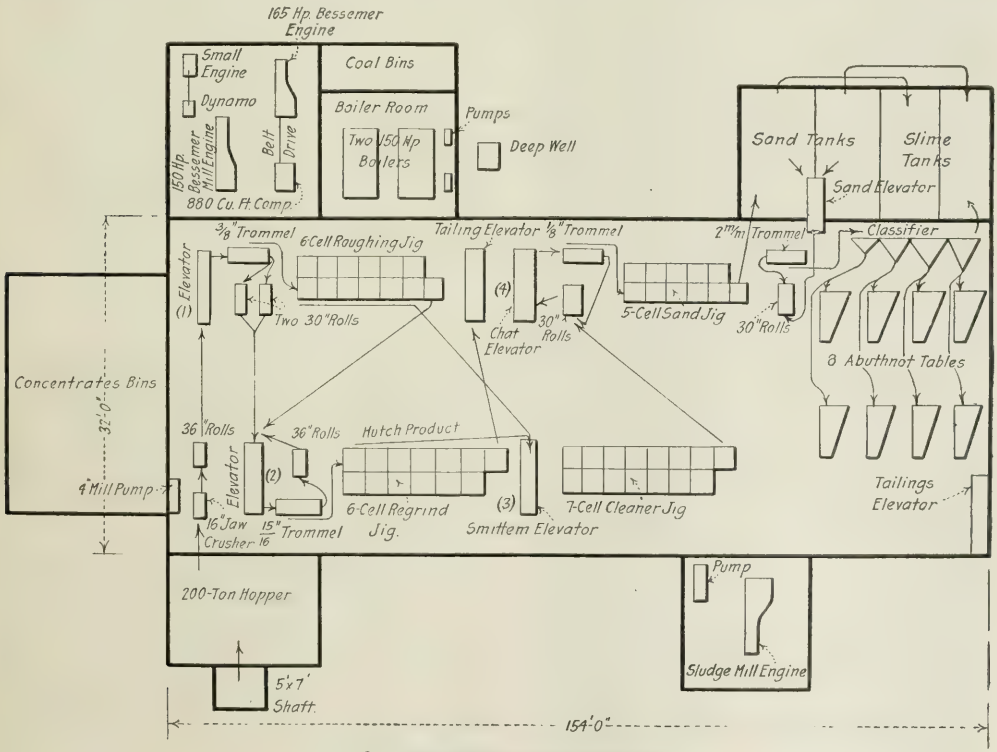

FIG. 2. FLOW SHEET OF JAY BIRD MILL

tanks, the first of which catches sand, while the second recovers the fine slime in the overflow.

The sand tank discharges to an elevator (5). The material is screened through a 2-mm. screen, the oversize being crushed in 30-in. rolls and returned to the circuit. The screened material, together with the slime from the second tank, is discharged into a 4-compartment V-tank, each spigot of which feeds a pair of tables. The V-tank overflow is returned to the settlement tanks. The table makes a clean lead concentrate, a clean zinc concentrate, a mixed lead-zinc-iron middling which is returned to the classifier, and a tailing which is wasted.

The capacity of the mill is 25 tons per hour, and it is operated 10 hours daily. The labor in the mill proper consists of the following:

	Per day.
Millman	$6.00
First helper	3.75
Second helper	3.50
Sludge man	4.00
Helper	3.50
Feeder	3.65

The average content of zinc in the ore as hoisted is about 7 per cent, while the tailing runs about 2 per cent, making what is called a "5 per cent recovery," or a 20:1 ratio of concentration. The diagrammatic plan gives an idea of the layout of the machinery as well as of the flow of the products.

Company Reports

The annual report of the **Granby Consolidated Mining, Smelting & Power Co., Ltd.**, for the year ended June 30, 1917, covers a period in which the management of the various properties was confronted by numerous difficulties of an unusual character. The business for the year showed a gross profit of $5,776,875, against which a charge was made for depreciation of equipment and depletion of ore amounting to $1,580,346. leaving a net profit of $4,196,529. Four dividends were paid, aggregating $1,349,961. The average New York price received for copper was 27.4 cents per pound. The cost of delivering copper in New York was 11.5 cents per pound from the Hidden Creek property and 20.8 cents from Phoenix. These figures compare with 10.09 cents and 14.25 cents respectively in 1916.

Metallurgical conditions at the company's Anyox smelter have been good. The loss of copper in slag was 0.23 per cent and the actual recovery was 87.7 per cent. The high cost per pound of copper is due to the high wages and increased cost of supplies, the latter averaging 40 per cent. At the Grand Forks smelter difficulty in operation was experienced due to shortage of coke, and the prospect is that fewer furnaces can be operated than in the past. This will mean an increase in operating cost even under normal conditions. To assure the company an adequate supply of coal and coke, steps are being taken to acquire coal land and to construct a by-product coke plant.

The beneficial results of the safety work of the company is shown in a comparative statement of average time lost per accident. In 1914 the average time lost was 33 days; during the 15 months ended April 1, 1916, this was reduced to 19½ days; in the 15 months ended June 30, 1917, 11 days.

Butte & Superior Mining Company's annual report for 1916 shows a net profit for the year amounting to $8,792,131 and dividends paid amounting to $9,490,429. Estimate of ore reserves as of December 31, 1916, shows 1,044,850 tons of ore averaging 17.7 per cent zinc and 5.65 oz. silver. Improvements and extensions were made during the year in every department of the milling plant. An entirely new coarse-crushing and storage department was constructed, and the capacity of the fine-crushing plant was increased. Important additions were made for handling slime and concentrate, with a view to recovering the maximum amount of water. Total ore milled amounted to 627,370 tons, an increase of 105,000 tons over the previous year. The average metal content of ore milled was 15.55 per cent zinc and 6.57 oz. silver. Mill recovery averaged 93.1 per cent of the zinc, an increase of nearly 1 per cent above the result for 1915. Costs increased abnormally, due wholly to higher wages and cost of supplies.

The quarterly report of the same company for the second quarter of 1917 gives the following principal operating data:

Dry tons of ore milled	126,737
Average zinc content (per cent)	15.304
Average silver content (oz. per ton)	5.5830
Zinc concentrates produced (tons)	37,670
Average zinc in concentrates (per cent)	46.509
Total zinc in concentrates (pounds)	35,039,606
Average silver in zinc concentrates (oz. per ton)	17.676
Mill recovery (per cent zinc)	90.329
Mining costs (per ton)	$4.7596
Milling costs (per ton)	$2.4001
Total costs (per ton) mining and milling	$7.1597

The above statement does not take into account the returns from or costs of treatment of 6325 tons of old mill tailings which produced 337 tons of concentrates containing 277,081 pounds of zinc. The tonnage of ore mined and treated fell considerably below that of the first quarter, very largely because of the unsettled labor conditions during almost the entire month of June. The average recovery of metals in concentration shows an improvement over that of the previous quarter, and the total cost of mining and milling, exclusive of taxes, decreased 18 cents per ton, due in part to a better adjustment of the milling operations. Replenishment of ore reserves by development amounted to 142,489 tons, or a net increase over the tonnage mined for the quarter of 17,500 tons.

Greater Co-operation with the Railways Needed

Mr. R. H. Aishton, president of the Chicago & Northwestern Railway and chairman of the Central Department of the Railroads War Board, addressed the convention of Associated Business Papers at Chicago on Oct. 12, on the railway situation. He brought out some important points which are given in the following extracts and which should be carefully considered. He said:

"In order to get more service out of each car they had to secure the co-operation of shippers in loading and unloading cars more promptly and in loading them more heavily. To save men and fuel for freight service they had to make reductions in passenger service which, up to the present time, amount to 25,000,000 passenger train miles a year.

"In order to secure the good will and co-operation of the public in doing these things the railroads had to get before the public the reasons why they had to be done.

"If the demands now being made upon the railways by military and commercial traffic should continue as heavy as they now are, or even increase for some time as it now seems probable that they will, the task of the railways is going to grow more and more difficult.

"The railways are working every locomotive and car and track to the utmost now. Shortage of labor and material make it extremely difficult to maintain adequately our present equipment, while it is practically impossible to get new equipment. It is almost impossible to get rails and other track materials to replace those being worn out.

"You will readily see what all these things mean. They mean that if the war goes on it is going to become more and more difficult for the railways to meet satisfactorily the demands on them. If this is the case the railways will need the help of the press more and more. They will need it in presenting the facts about railway conditions to the public, in urging the public to co-operate with the railroads in all the ways that it can and also in urging the public to be tolerant regarding any delays and inconveniences to which it may be subjected.

"I do not suggest that you gentlemen of the business press should do this for the benefit of the railways, for I know you are not specially concerned with the welfare of the railways. But you are specially concerned regarding the welfare of the great industries with which you are identified, and you are more vitally concerned for the welfare of your country.

"One of the most effective ways in which you can serve those industries and your country in this great emergency is by using your powerful influence to get the business interests to co-operate with the managements of the railways in every way they can so as to enable the railways to handle the unprecedented traffic which is now moving and which, so far as we can see ahead, will continue to move for months to come."

Gas and Flame Service Regiment

The commanding officer of the Thirtieth Engineers has issued a call for men to serve in the "Gas and Flame" Division.

This regiment is being recruited now from men volunteering for the service and will be ready to go "over there" by Thanksgiving.

The regiment will be required in the field of operation to supervise the American offensive in "Gas and Flame" service and will be called upon to instruct men all along the front in this most important work.

The Thirtieth is the pioneer regiment in the "Gas and Flame" service. Men who enlist now will be leaders in the spring offensive.

Chemists (analytical, research and manufacturing). Chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, men able to operate and repair gas or steam engines, pipe fitters, electricians, designers, interpreters, carpenters, blacksmiths, plumbers, boiler-makers and chauffeurs are wanted.

Men with long experience in their trade are especially desired to fill the master engineer grades.

All men enlisted in the Thirtieth must have good muscular development and be capable of undergoing active service at the front.

Men are wanted who know how to take care of themselves, who are active, energetic, and have a strong determination to carry out any mission to which they may be detailed.

Loyal American citizens with the above qualifications between 18 and 40 years of age, who have not actually been called by a local board in the draft, are eligible for enlistment.

Col. A. A. Fries, Engineers, N. A., is to be the commanding officer of the Thirtieth Engineers. He is a regular officer of the Corps of Engineers, with many years' experience in military and civil engineering. Colonel Fries is now in France and is "Chief of the Gas Service."

Major E. J. Atkisson, Corps of Engineers, is organizing the first battalion of the Thirtieth Engineers at Camp American University, D. C. He is a graduate of West Point and of Cornell University.

In order to enlist it is only necessary to go to the nearest recruiting station or U. S. District Engineering Office, state fully and clearly your qualifications and that you wish to be enlisted in the Thirtieth Regiment of Engineers (Gas and Flame).

All men must first enlist as privates, the rate of pay being $33 per month and expenses. Men with the necessary experience may be assigned to special duties and given non-commissioned rank at rates of pay ranging from $40.20 to $96 per month and expenses. The latter include, for both privates and non-commissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur.

Manufacturers are requested to bring this notice to the attention of their organizations.

American Coal Tar Products Production to Be Ascertained by the Tariff Commission

The United States Tariff Commission is planning to ascertain the production within the United States during 1917 of all substances treated in Title V of the Special Tariff Act of Sept. 8, 1916. The substances there enumerated may be classed under the general name Coal Tar Products, and are divided into three groups.

Group I includes "all products that are found naturally in coal tar, whether produced or obtained from coal tar or other source," except phenol. These substances are admitted free of duty.

Group II includes the so-called intermediates, and are made dutiable at 15 per cent plus 2½c. per pound.

Group III includes "all colors, dyes, or stains, whether soluble or not in water, color acids, color bases, color lakes, photographic chemicals, medicinals, flavors, synthetic phenolic resins or explosives, not otherwise specially provided for in this title, when obtained, derived or manufactured, in whole or in part, from any of the products provided for in groups I and II." These articles are dutiable at 30 per cent plus 5c. per pound, with certain exceptions which are dutiable at 30 per cent.

Under the law the duties are made dependent on the growth of the industry within the United States. It is, therefore, the intention of the commission to follow this growth from year to year in order to report the facts to Congress.

The Tariff Commission is planning to send to each manufacturer a questionnaire calling for information in regard to his production during 1917 of each separate commodity, as well as for certain other data. This information will be published in such a form that the operations of individual firms will not be disclosed. A preliminary questionnaire has recently been sent out, designed to aid in perfecting the mailing list. Any individual or firm engaged in the manufacture of any of these articles which did not receive a copy of the preliminary questionnaire is requested to write to the United States Tariff Commission, Washington, D. C., to insure being placed on the mailing list.

British Munitions Commission Discusses Labor Question

Tells How England Has Fixed Profits and Wages, Suspended Union Rules and Handled Female Labor

An important series of executive conferences was held during the weeks of Nov. 5 and 12 in New York, by the British Munitions Commission, which recently came to this country, and various manufacturers and trade and technical press representatives. The conferences were held under the auspices of the Mayor's Committee. Several of them were held in the Merchants' Association headquarters in the Woolworth Building. Others were held at various places. Sir Stephenson Kent is the head of the commission.

On Friday, Nov. 9, two members of the commission, Messrs. Garrod and Baillie, met representatives of the chemical, drug and allied industries. Both commissioners delivered short addresses, and these were followed by an open round-table discussion which brought out many exceedingly interesting points.

Commissioner H. W. Garrod explained that in March, 1915, when it was felt that some action on the labor question was necessary, the parties who could speak for the industries, i. e., the Employers' Association and the parties who could speak for the trade unions were brought together and the so-called Treasury Conference was held, at which it was agreed that there were to be no strikes or lock-outs in munition works during the war. The Munitions Act was an outcome of these agreements. The unions agreed to abandon all restrictive measures such as favored closed shop and men working at only one trade. Where any dispute arises it is compulsory to submit it to Government arbitration. It was also decided that anyone could be employed during the war, and that after the war the unions will be restored to their former status.

Regulation of Wages

The Government also took up the regulation of wages, and they were fixed definitely and based on the rate in effect in the various districts before the war. Since the war started a million women have been employed in England in munitions work (a term which includes all war supplies). The women receive the same pay as the men on skilled and piece work and two-thirds of the men's wages in other cases, as it was found by experience that three women were needed for two men's jobs on the unskilled work. Only three serious strikes have so far resulted and none of these has been for an increase in wages. The union officials have shown great patriotism in standing by the Government.

Excess Profits to Government

As a large percentage of the profits of the manufacturers had to be paid into the Exchequer, the employers had to have some restrictions on wages. Munitions Tribunals, or domestic courts, were formed at which all offenses of employees or employers are tried.

Engineering and Chemical Industries

Commissioner Baillie in his address said his experience had been mostly with the engineering and chemical industries. By engineering industries he meant machine shops and heavy metal fabrication. A great shortage of labor for these industries—the most important of all—was encountered. This was on account of the skilled labor needed. The schemes adopted to cope with this situation were mainly the dilution of skilled labor, or grading up process, whereby unskilled workmen are taken in and placed on the easy jobs first; and the breaking up of skilled jobs into parts, the least skilled parts being done by the green workmen.

In the shell, fuse, hand grenade and cartridge factories 80 per cent of the laborers are women. Women are also doing skilled work in the production of aeroplanes, guns, etc. They are also doing laboring work of all kinds in the chemical factories and are also handling processes. In picric acid all operations on the drying end are handled by women. In T. N. T. 50 per cent of the laborers are women. In T. N. T. plants the women are required to take two weeks rest after every period of three months' work. Women are working in all operations on fulminate.

An interesting incident was related by Mr. Baillie in connection with a fire which broke out in a picric acid plant. The men all disappeared and the manager with the women put the fire out.

Discussion

In reply to a question on segregation of men and women, Mr. Baillie said it had not been found highly important and was not in force to any extent. Special women superintendents are appointed to look after the welfare of the women employees. He said it was forbidden to entice labor by competitive bidding, and that leaving certificates are issued. These are only for jobs requiring higher skill and are not issued where a man is simply leaving to get more money on the same work. Provision has been made for increasing wages, dependent on the cost of living. A Commission of Productions was organized, whose business it is to look into the cost of living three times a year. Usually an award is given instead of a wage increase where the cost of living warrants it.

Sixty working hours per week is the limit for women. The normal time in explosives work is 48 and in engineering 52 to 54. There is no limit for men. In general the women have been found more careful than the men.

Commissioner Ballie said very few industries were forced to completely shut down, as they could usually find some war work to do, even though in many cases it was not sufficient to keep the factory running to anywhere near capacity.

In regard to conscription of labor it was brought out that England could not conscript labor, but could tell an employer he could not employ certain men, which is almost the same thing. Conscription of labor is not necessary however, as the skilled men, to the number of more than 200,000, have been grouped as "Volunteers of Munitions," which they will continue to be for the time of the war. They willingly go wherever the Government sends them. Too much emphasis, the American employers were told, could not be laid on this willingness of the British worker to serve his country.

Investigation of Manganese Situation

On account of the increasing difficulty in obtaining imported manganese, and the vital importance of manganese for the production of the steel needed in making war, the Bureau of Mines is making a thorough investigation of the possibilities of relief through a more extensive use of domestic ores. On account of the steel industry being dependent on manganese, and on account of the problems of ore concentration being similar to those of iron ore, these investigations have been assigned to the Lake Superior station recently established at Minneapolis. Although the bureau realizes the importance of taking up the iron-ore concentration problems at the Lake Superior station as soon as possible, yet such work is obviously to be classified among the "peace-time problems" relating to conservation; whereas the manganese investigation, under present conditions, is strictly a "war problem" dealing with increased production.

The Lake Superior region is an important producer of manganiferous iron ores; it contains large reserves of these ores, and can mine and ship much larger amounts if metallurgical practice can be so modified as to make ores in better demand.

For many years our steel makers have relied on manganese alloys imported from England, and on manganese ores from India, Russia and Brazil. These imported ores are high in manganese and are suitable for making 80 per cent ferromanganese, the alloy that has been desired in greater quantities because of a larger proportion of our steel being made by the open-hearth process.

With the low ocean freight rates that prevailed generally during the 10 or 20 years, it was well-nigh impossible for producers of domestic manganese ore to compete with imported ore. Consequently the manganese industry of the United States languished. There was little or no incentive for the exploration and development of manganese ore bodies and their mining was carried on without system.

WAR CHANGES CONDITIONS

With the outbreak of the war in Europe in 1914 the manganese industry of the world faced new conditions. The entrance of Turkey into the war cut off shipments of the Russian ores from the Caucasus region. A growing scarcity of available ocean tonnage has made it increasingly difficult to transport the material from the usual producing countries, and the great rise in ocean freight rates has increased the cost of imports. Consequently, producers in the United States face an unprecedented demand.

Until last year this demand had little if any effect on production because of the difficulty of interesting capital in an industry that might die with the ending of the war. A clearer and broader conception of the causes of high manganese prices, and a belief in the likelihood of these causes existing for some time after the close of the war, has partly removed that tendency. A far greater difficulty in obtaining domestic supplies is the fact that manganese ore of high grade, suitable for making 80 per cent ferro, is very scarce in the United States, manganiferous iron ores being much more abundant. Such ores have not been in much demand by the steel industry in the past, and it is essential to investigate carefully, by research on a large scale, the possibilities and limitations involved in their use. It is this work that the Bureau of Mines desires to carry out as rapidly as possible. The sooner the facts can be determined the more valuable they will be.

The bureau realizes that much information has been accumulated by various Federal and State bureaus, technical societies, private operators, and individuals. Duplication of present effort and of any reliable results already obtained must be avoided in order that the Bureau of Mines may devote its time to questions that have not been clearly answered as yet. For this reason the bureau hopes to work in a spirit of cordial cooperation with all agencies interested in the problems to be solved, with producers and consumers of manganese ore and alloys and with individuals. Such cooperation is essential in order to serve the country well in the effective conduct of the war. A proper coordination of all data now available and of the data obtained in attacking these problems will be of tremendous assistance. Proper credit for such cooperation and assistance will be gladly given wherever possible. Suggestions and constructive criticism will be greatly appreciated.

The bureau plans to assemble and tabulate as much information as possible concerning the character and available tonnage of known domestic ores, the current practice in mining and concentration, and the present methods of manufacturing manganese alloys and of using them in steel. When compiled, this material should afford a starting point for various original researches dealing with related problems.

The possibility of concentrating various types of ores will be studied by detailed tests and experiments, fundamental thermo-chemical data relating to manganese and its compounds will be determined, and the equilibria of certain fundamental reactions between iron and manganese compounds will be studied. Also much attention will be given to the development of possible substitutes for manganese in steel making; to the possibility of using more extensively alloys that are not used in what is now considered standard practice, such as alloys containing between 20 and 80 per cent manganese, and alloys containing manganese and other constituents, and to the possibility of increasing the manganese content of basic pig iron in order to lessen the amount of manganese alloy added at the end of a heat, part of this being left as residual manganese in the bath metal. Another problem that will be studied in the light of the results already obtained will be the production of manganese alloys in the electric furnace in localities where power is cheap. During the past summer the bureau has been carrying on a series of experiments in Pittsburgh on the production of alloys in the electric furnace from slags high in manganese.

Much of the work relating to present practice, also certain researches, must necessarily be conducted in the field at mines, concentrating plants, blast furnaces and steel works. In the laboratories of the Lake Superior station, which is situated at and co-operates with the University of Minnesota, at Minneapolis, concentration tests of ores will be made and fundamental laboratory data will be collected. Arrangements are now in progress for co-operative work on other problems at

laboratories throughout the country that are equipped to do work of the desired character.

The persons actively engaged in these manganese investigations will comprise the staff of the Bureau of Mines attached to the Lake Superior station, the staff of the Minnesota School of Mines Experiment Station, and those members of the Bureau of Mines who may be particularly qualified for certain phases of the work. In order to make this work of the most practical value it is planned to organize a number of advisory committees composed of mine and furnace operators.

Conserving and Increasing Supplies of Foodstuffs

New York Section of American Chemical Society Holds Interesting Meeting

The second regular meeting of the season of the New York Section of the American Chemical Society was held at the Chemists' Club on Friday evening, Nov. 9. The chairman, Dr. Chas. H. Herty, presided.

A few business matters were disposed of before the program was given. Dr. Allen Rogers reported on the work of the Press and Publicity Committee, which has been doing such splendid work in getting chemistry and its value before the public. The chairman appointed Drs. Love and Teeple and Professor McKee as a nominating committee to nominate local councillors.

The first paper on the program was by H. A. Baker of the American Can Company, who spoke on the canning industry and pointed out several ways of conserving and increasing foodstuff supplies. He mentioned especially the important experimental work of the National Canners' Laboratory in decreasing the amount of tin required in tin cans and in solving many of the problems relative to the canning process proper. He mentioned the great waste in the canning industry in peels, corn cobs, etc.

"At present," Dr. Baker said, "only 50 per cent of tomatoes delivered at the factory are turned out in the canned food product. Thousands of tons of pear peelings are wasted because they do not make a vinegar that tastes like vinegar. Thousands of tons of fish scrap, particularly on the Pacific Coast and Alaska, are wasted because easy and profitable methods of getting the values out of them have not been devised. Enormous quantities of green corn cobs are allowed to ferment, and are used for fertilizer and cattle food, when it is well known that there is more sugar left in the cob than was taken off in the corn.

"Probably many kinds of bacteria which only destroy food could be made to do useful work producing useful substances and chemicals, if they were thoroughly studied and put to work. Enormous quantities of sea food, which cost nothing to grow, are unused because no one has prepared them palatably and attractively. Unlimited quantities of shark and grayfish are not used because they happen to contain a small quantity of urea which, in cooking, turns into ammonia."

In reply to a question, Mr. Baker said that aluminium-lined containers would not be practical owing to the difficulty in soldering. Enameled cans, he said, reduce absorption of metal. The enamel is put on over the tin and baked at 370 deg. Fahr. It is a linseed-oil-gum product.

The subject of cotton oil and other edible oils was discussed by Dr. David Wesson of the Southern Cotton Oil Company. He said the edible fat problem was an extremely important one. Our increased production of peanut has somewhat offset the decreased cotton oil production, as have also increased imports of soya bean and cocoanut oil. The supply, however, of edible oils will not be large enough unless the strictest economy is used. Dr. Wesson advises that edible oils should not be used in soaps and other industrial lines where substitutes can be found. He also mentioned a number of products which should find greater use, such as oleomargarine and cheese made from skimmed milk and cottonseed oil. He said that chemists should point out to Congress the harm in existing food laws in taxing and limiting the use of perfectly good and wholesome substitutes.

Upon motion of Dr. Jerome Alexander, it was decided to recommend to the President and council of the society that some action be taken in the matter just referred to.

Dr. T. B. Wagner said that corn oil is now being converted into edible oils. About 150,000,000 bushels of corn per annum are used in the corn products industry and 1-1½ lb. of oil per bushel can be obtained.

The other papers were by J. A. LeClerc of the Laboratory of Plant Chemistry in Washington and L. P. Brown, J. T. Atkinson and Thos. McMeekan of the Bureau of Foods and Drugs, New York City.

Sulphur and Pyrite in 1916

The Geological Survey has recently completed the compilation of statistics regarding the production of sulphur, pyrite, and sulphuric acid in the United States in 1916. The last named has been given in a previous issue.

No statistics regarding the production of sulphur will be made public, as 99 per cent of the sulphur produced in the United States came from only two companies. The importations of sulphur were practically the same as for the last five years, amounting to 22,235 long tons, valued at $404,784. The exports however, increased nearly 350 per cent over the exports in 1915, amounting to 128,755 long tons, valued at $2,505,857.

Never before was so much pyrite produced or imported by the United States and prices for this material increased throughout the year. The increase in production is to be attributed mainly to the greater yield from old mines rather than to the opening up of new deposits. The domestic production of pyrite in 1916 was 423,556 long tons valued at $1,965,702, which is about 30,000 long tons more than was produced in 1915 and was valued at about $290,000 more than the ore produced in 1915. The consumption of pyrite ore—that is, the domestic production together with the ore which was imported, amounted to about 1,670,000 long tons. In addition to the pyrite ores reported here, returns from acid manufacturers show that 577,045 long tons of domestic copper-bearing sulphide ores; 196,404 long tons of foreign copper-bearing sulphide ores; 531·625 long tons of domestic zinc sulphide ores; and 92,002 long tons of foreign zinc sulphide ores were treated in 1916 for their sulphur as well as for their metallic content.

Regulation of Explosives Goes Into Effect

President Wilson has issued a proclamation relative to the Explosives Act passed by Congress and approved by him on Oct. 6, 1917. In this act it is provided among other things that from and after forty days after the passage and approval of said act no person shall manufacture, distribute, store, use, or possess explosives or ingredients thereof, not including explosives for the military or naval service of the United States of America under the authority of the government or ingredients in small quantities not used or intended to be used in the manufacture of explosives, and not including small arms or shotgun cartridges, unless such person shall obtain a license issued in the name of the Director of the Bureau of Mines, except that any workman may purchase or accept explosives or ingredients thereof under prescribed conditions from a licensed superintendent or foreman. The Director of the Bureau of Mines is also authorized to utilize the various federal, state and municipal officers, agents and agencies in the execution of the act.

According to the President's proclamation, the law is to take effect November 16, 1917, and continue in force during the war.

Mr. Francis S. Peabody of Chicago, a well known coal operator familiar with the use of explosives, large amounts of which are used in the coal mining industry, has been appointed by Secretary of the Interior Lane to act as assistant to the Director of the Bureau of Mines Van H. Manning in the enforcement of the law. The police of the cities have already been organized for this work, headed by a committee of chiefs of police in the big cities, of which Major R. W. Pullman, superintendent of police of Washington, D. C., is chairman. The police are not only to look after the enforcement of the law, but are also to make thorough investigations of all dynamite outrages and fires in factories and warehouses and to make their reports to the Director of the Bureau of Mines.

The law provides that everyone who handles explosives must have a license. The manufacturer, the importer and the exporter must have licenses issued by the Bureau of Mines in Washington. The seller of explosives and the purchaser of explosives must also have licenses, these to be issued generally by county clerks, or other local officers who are authorized to administer oaths. There will be at least one licensing officer in each county, and more agents will be designated if the county is sufficiently large to warrant it. If a state has laws providing for a system of licensing persons manufacturing, storing, selling or using explosives, the state officials authorized to issue such state licenses shall be designated as federal licensing agents; also city officials qualified to issue city explosives licenses will be given authority to issue federal licenses. A federal license will not relieve any person from securing licenses required under state laws and local ordinances.

In each state there will be appointed a state explosives inspector, who will represent the Bureau of Mines in the administration of the law within the state.

Only citizens of the United States or of countries friendly to the United States and the Allies may so obtain licenses.

Contractors, mining companies, quarrymen and others using large quantities of explosives, which are handled by employees, may issue explosives to their employees only through those employees holding a license, called a foreman's license.

The purchaser of dynamite, in obtaining a license, must state definitely what the explosive is to be used for and will be held accountable for its use as stated and the return of any explosives that may be left.

A New Government Employment Service

The United States Department of Labor recently created, as a part of its employment service, a division whose function it is to aid the employer in obtaining suitable help, and professional persons in securing suitable employment. This is known as the Teachers and Professional Service Division. While intended to embrace all professions, attention has thus far been confined to the teaching and engineering professions. The services of the Division are absolutely free to both employer and employee, all expenses being borne by the Unitd States Government. Its methods are quite thorough, and no service is rendered the applicant until the Division has learned, from persons familiar with the applicant, that he is qualified as to training, experience and personal qualities for the position he seeks. When an applicant is recommended for a reported vacancy, the employer is given an opportunity to examine the data gathered in the course of this investigation, thus effectually preparing for the final and most important step, the personal interview, and for this ample facilities are provided in the offices of the Division where employers may meet with prospects on appointment.

Employers and professional engineers everywhere are invited to avail themselves to the services of this Division which, as stated above, are entirely free. Employers in reporting positions are asked to state the nature of the position, its duties, requirements, etc., the probable salary, and probable duration of employment. Applicants for registration should indicate in the first letter the nature of the position desired so that the proper blank may be furnished. All communications should be addressed: Teachers and Professional Service Division, U. S. Employment Service, 845 South Wabash Avenue, Chicago, Illinois.

New Tennessee Potash Plant

Work has been started on the new potash-recovery plant of the Clinchfield Portland Cement Corp., at Kingsport, Tenn. This plant will employ the Cottrell or electrical precipitation system in its latest form, and will include a wet treater by means of which potash salts will be obtained. Incidentally, it may be said that the wet treater is not only less expensive to install than the dry treater heretofore employed, but the potash salts obtained by it bring a much higher price per unit than the potash-bearing dust from the hydrator. There will also be a much better market for the salts than for the dust after the war is over and the German product comes back to this country. In the plant at Kingsport the engineers have worked out a system by means of which the evaporation of the solutions will be effected by means of the waste heat from the kilns. Richard K. Meade & Co., consulting engineers of Baltimore, Md., are the designing and constructing engineers for the plant.

The Use of Enemy-Owned Patents

In our semi-monthly review of recent metallurgical and chemical patents issued by the United States we have continued to publish those of importance which have been granted to citizens of enemy countries. Inquiry received regarding this matter suggests the need of an explanation of the status of enemy-owned patents in this country, as defined by the trading-with-the-enemy act passed by the last Congress. This act contains various provisions as to the application for patents in enemy countries by United States citizens; for the suspension of information as to certain patent applications made in the United States where secrecy is necessary for military reasons; and for the use in this country by our citizens of enemy-owned patents during the period of the war.

The door is not closed against enemy citizens who may wish to secure letters patent in the United States, but provision is made whereby our manufacturers may be licensed to use such patents in their business. The Federal Trade Commission is empowered by the President to deal with these matters, receiving applications and granting licenses. For the privilege of using enemy-owned patents it is necessary to pay to the Custodian of Enemy Property 5 per cent of the value of the products made under such patents. At the close of the war the enemy owner may, within one year, sue for the recovery of royalty on the use of a patent. If the courts grant him the right to recover, the 5 per cent fund shall apply on such royalty; but if the right to recover is denied, then the 5 per cent shall revert to the manufacturer. It seems scarcely probable that enemy citizens will be allowed by their governments to continue to patent important processes and devices in the United States, but if such is the case we are privileged to make use of them under the restrictions outlined.

Cincinnati Meeting of the American Iron and Steel Institute

(*Continued from page* 524)

Mr. D. B. MEACHEM of the Rogers, Brown & Co., a member of the local committee, spoke on "Cincinnati and Its Industries."

The next paper, entitled "Recent Installations of Large Electric Motors in Rolling Mills," was presented by Mr. S. S. WALES, electrical engineer of the Carnegie Steel Company. In this paper he started with the introduction of electric motors into steel works in 1890, at which time an attempt was made to adopt the street railway type motor to movable machines, such as cranes, and traced the development of the highly specialized type of motor in use at the present day.

He then proceeded to show in what ways the motor replaced the steam engine, and how to-day it is beginning to replace the hydraulic cylinder.

After commenting on the introduction of the steam turbine and its effect on the adoption of main mill motor drives, he considered in detail the various types of motors and drives employed, and discussed the question of standard ratings for large motors. In regard to costs, he showed that while the original outlay may not vary much from that required by a steam plant, however, due to the centralization and higher efficiency obtained with the turbine and the electric drive, it is possible to make a saving of as high as 50 per cent in the fuel consumption.

In discussing this paper Mr. D. B. RUSHMORE of the General Electric Company, and Mr. W. SYKES of the Westinghouse Electric & Manufacturing Company called attention to the fact that to-day the electric motor has entirely replaced the steam engine for the main mill drive.

In a paper on "Iron and Steel Scrap," Mr. W. V. PHILLIPS contributed much interesting and unusual information in regard to this important but neglected subject. He commented upon the value of scrap, showing how it is based upon supply and demand, and to a certain extent upon the value of the raw products it replaces. He also mentioned the organization known as the American Board of Iron Scrap Dealers and its relation to the government and business at large in trying to standardize the various scrap classifications and eliminate the dishonest dealer.

The afternoon session was opened by Mr. J. G. BUTLER of the Brier Hill Steel Company, who, in an historical and informal manner, touched upon his fifty years' connection with the iron and steel industry.

Mr. H. F. POPE presented a paper on "Malleable Iron and Its Uses." After briefly discussing the casting of the iron and its subsequent annealing, he pointed out the difference between American and European practice. He then proceeded to enumerate the advantages of malleable iron over wrought iron and cast steel, showing the desirability of its use in many places.

Professor ENRIQUE TOUCEDA of Rensselaer Polytechnic Institute, in discussing this paper, called attention to the remarkable similarity in the properties of malleable iron and wrought iron, which are wonderfully close when we consider the great difference in the method of manufacture, and he and Mr. F. J. Lanahan of the Fort Pitt Malleable Iron Company, Mr. F. E. Nulsen of the Missouri Malleable Iron Company, and Mr. J. S. Haswell of the Dayton Malleable Iron Company called attention to the necessity of complete control throughout the process, which is being brought about by its increasing use in the automobile industry.

Mr. NULSEN brought out the point that it was due to the large use of malleable iron that the American automobile was so much lighter than the modern European car.

Both Mr. NULSEN and Mr. HASWELL commented on the great resistance to wear and oxidation of high grade malleable iron, and said that due to this fact and the present abnormal price of steel it was replacing the latter in many places.

A paper entitled "The Export Trade as Affected by the War" was read by Mr. E. P. THOMAS of New York. Mr. Thomas brought out the point that due to the war our capacity for production of steel had increased to such an extent that when the war is over we will have to depend on our export trade to take care of the surplus production. He called attention to the importance of a merchant marine in this respect.

He touched to considerable extent upon the importance of the Minette-Lorraine district in Europe, especially in relation to the terms of peace, proving by statistics that Germany depended upon it for about 80 per cent of its raw material for the iron and steel industry.

The Furnace Refining of Copper

By Lawrence Addicks

In the early days copper was produced by a succession of roasting and fusing operations based upon the fact that copper sulphide when melted with copper oxides react to form sulphur dioxide gas and metallic copper. This was the basis of the celebrated Welsh process. Then it was found that if the operation was so conducted that a small metal fall was obtained first, these "bottoms" would contain most of the impurities, including gold (silver was frequently separated by a sulphatizing roast and subsequent wet extraction), and the balance of the copper produce would be correspondingly purer. This is the characteristic "best selected" process used in England and the basis of the "Argo" process for separating gold from copper.

While converting has supplanted roasting and electrolysis reverberatory refining for the great bulk of the world's copper, although the melting of Lake mineral in Michigan and various small-scale operations abroad are notable exceptions, the electrolytic process has retained two reverberatory steps, the anode and refining furnace operations, in the metallurgical scheme.

Blister copper produced directly by the converter does not make desirable anodes, although special conditions at one refinery has made their use profitable. For the general case the principle has been well established that work which can be done in the anode furnace should not be done in the tank house. The guiding principle in tank-house operation is to do whatever is necessary to obtain uniformity of operating conditions, and converter anodes give trouble unless a very pure blister is being treated.

The function of the anode furnace is to make a perfect anode casting in which the sulphur has been thoroughly removed and other oxidizable impurities slagged off as far as possible.

The refining furnace serves merely to put the cathodes into desired physical shape and beyond the elimination of traces of sulphur and adjustment of "pitch" has ordinarily no chemical function. Nevertheless the methods of operation of the two furnaces are identical in many respects and the discussion of the general principles involved is applicable equally to both.

Just as many of the operations in smelting are based upon the marked affinity between copper and sulphur, so the basis of furnace refining is the relative weakness of the affinity between copper and oxygen. The general plan is therefore to oxidize the impurities the oxides of which will then either escape by sublimation or float on the surface of the bath, from which they may be skimmed or slagged. According to this method it should be possible to remove all elements less noble than copper, leaving simply silver, gold and the platinum group alloyed with the copper. The same principle of resistance to oxidation is reversed in the tank house, the copper oxidizing to sulphate at the anode and the more noble metals remaining behind in the slimes. Theoretically we have, therefore, a perfect separation of the copper, the impurities and the values.

In practice the system does not work out so perfectly, as mass action comes into play. It is quite easy to remove the bulk of most oxidizable impurities in the anode furnace, but as the amount present becomes less and less it is increasingly difficult to make further removals, and carried to absurdity the entire charge would be slagged in order to remove the last traces. Then some elements such as arsenic readily form direct compounds with the more basic metals, and these cannot readily be broken up. The degree of elimination of impurities depends therefore upon: (1) the amount of impurity present; (2) its affinity for oxygen; (3) its affinity for copper, and (4) the extent to which scorification is pushed.

Scorification consists of using an element as an oxygen carrier. In this case the principal scorifying agent is copper in the form of cuprous oxide. The process is to oxidize with an air blast some of the impurities directly and a part of the copper by air. The cuprous oxide formed dissolves in the bath and penetrates to all parts of it, reacting with elements which have a greater affinity than copper for oxygen and reducing out an equivalent amount of copper. These basic oxides further react with any acid material, such as silica in the furnace walls, that may be present and the resulting slag is skimmed off, leaving a purified bath holding a considerable quantity of cuprous oxide in solution.

The reducing stage necessary to throw back the cuprous oxide is now accomplished by generating a hydrocarbon gas by the destructive distillation of hard wood poles thrust beneath the surface of the bath, which is covered by a blanket of carbonaceous material to protect it from any further oxidation. The various steps will now be taken up in detail in the order in which they occur.

CHARGING

A reverberatory furnace is used for this work operated on a twenty-four-hour cycle. Starting with an empty furnace the first operation is charging. In the early days this was accomplished by hand, one pig or cathode being charged at a time. Two men would lift a pig to the end of a peel held in position at a charging door by a third man. This peel was a long heavy steel bar flattened like a paddle at one end. The three men would then thrust the peel into the furnace and flip the pig off at the desired location.

Various mechanical devices were tried to improve this practice, but for a long time the only successful innovation was the use of air lifts and tongs in placing the pigs on the peel. As furnaces gradually increased in size the time required to charge them became inordinate, and not only was the twenty-four-hour cycle badly disarranged, but the furnace cooled off badly during the delay. These difficulties led to trials of charging cranes developed in the open-hearth steel industry, but they were at first unsuccessful, due to a lack of fundamental differences between the two problems. The open-hearth furnace has a small charge simply thrown in it while the copper reverberatory by the old practice was piled with pigs clear to the roof. The first result of mechanical charging was an enormous loss in cold capacity which more than offset the other advantages gained. This failure checked further development along these lines for some time until a special form of peel consisting of a fork with a special pushing device (Prosser & Ladd, U. S. Patent) was devised to replace the upsetting shovel of the old type. This crane met with immediate success, and it was found possible to charge 5000 lb. at a time at a

rate of at least 200,000 lb. an hour and lose nothing in cold capacity as compared with the hand method, while at the same time charging a 200-ton furnace as quickly as the old 50 and 75-ton units had formerly been handled.

The main thing in charging is to have material which will stack well. This means that pigs should have a good blister finish and not be overblown and that cathodes should be reasonably smooth. When this is not the case individual charges after piling in the furnace will spill and take up much more space.

The next development along this line was the use of the crane for recharging after melting the first batch. In this way a certain molten tonnage in excess of the normal cold capacity of the furnace can be obtained.

Then it was found that anode scrap could be recharged to a certain extent while the metal was being poured. Finally cathodes were successfully charged while the refined copper was being poured (Addicks and Marks U. S. Patent No. 980,584). This will be referred to again later on.

In this way the limit to size has been practically eliminated as mechanical charging will rapidly take care of any sizes of furnace which can be built and the cost has been brought down greatly as the hand method exposed the crew to very severe heat.

MELTING

The next step in refining is the melting of the charge. This consists merely of burning as much fuel as the furnace can take care of. Copper is a good conductor of heat and the piled-up charge through which the hot gases have to filter absorb heat very rapidly. The melting is divided into three stages: (1) "softening," when the hot mass collapses; (2) "coming flat," when the molten metal covers the softened mass; and (3) "coming afloat," when the balance remaining on the bottom is absorbed.

It has been found that a semi-bituminous coal running about 20 per cent in volatile matter gives a desirable length of flame for this work. It is most essential that the coal should not form a fusible ash as deep fires are carried, and unless they are free burning a great deal of delay is encountered. In a refining furnace the old practice has been to fire heavily during the early stages of the refining and carry a bed of coke for heat during the later part so as to avoid sulphur from the fuel reaching the copper. With the present large charges, and particularly when recharging, while pouring it has been found necessary to fire more steadily and without any apparent untoward effect.

FLAPPING

When the charge is afloat a button is taken in a "say ladle," and if this throws a "worm," indicative of sulphur, a pole is introduced to agitate the bath, which is exposed to the air until a button sample shows a surface which is unbroken on cooling. This practice has a bearing on "overpoled" charges of refined copper to be taken up later.

The system of using buttons for samples is very old, but still stands as the best method of controlling furnace refining. A small ladle with a cup about an inch and a half in diameter is warmed by holding over the bath for a moment, then used as a rabble to sweep a clean face at the spot where the sample is to be taken and then plunged beneath the surface and quickly withdrawn. The sample thus obtained is allowed to "set," when it may be dumped into water to cool for handling. Both the surface and the fracture upon nicking with a chisel and breaking in a vise give clear indications as to the state of the bath of copper. When sulphur is present a small volcano forms on cooling, which throws out a part of the metal which twists around as it chills much like a worm. When excess oxygen is present the surface shows a deep depression, and when the bath is nearly saturated with cuprous oxide this depression will break inward into a cavity. Copper at desired "pitch" for pouring will show a full rounding slightly wrinkled surface. Overpoled copper begins to "spew" and show the above-mentioned sulphur indications.

In the same way the condition of affairs may be noted by the color and structure of the fracture. When copper is saturated with cuprous oxide (about 6 per cent Cu_2O, beyond which point further oxidation will only cause useless slagging) the fracture shows a marked cubical structure, brick-red in color. As the oxygen is poled out the structure becomes more fibrous and the color brighter until we reach the lustrous silky texture corresponding to properly refined copper.

These simple tests enable a practiced eye to follow the refining operations with very satisfactory accuracy, and consequently metallographic and other methods have not come into use to any extent.

When the sulphur has been poled out the flapping or blowing begins. Originally a rabble was swung from a chain at the furnace door and the surface of the metal flapped or broken into spray by swinging this back and forth with free admission of air at all doors. This is hot and fatiguing work, and as the size of furnace charges increased it again became necessary to find some mechanical substitute. This was accomplished by blowing compressed air beneath the surface of the bath, sending up a fountain of molten metal instead of a mere splash and at the same time thoroughly stirring the bath itself. The great objection to this procedure has from the beginning been the consequent damage to the furnace structure. The fountain is so violent that more or less of the spray reaches the roof of the furnace and the metal highly charged with cuprous oxide avidly attacks the silica brick wherever it touches it. The large modern furnaces tend toward excessive repair costs as one of their disadvantages, and this corrosive action aggravates a situation already bad. When basic or neutral material such as chrome brick is substituted for acid brick construction, this trouble disappears; otherwise constant attention must be given to restraining the men in control of the air blast who naturally tend to over-vigorous application in order to gain time. Another remedy would be the use of low pressure air, which would not give such violent agitation, but the standard 80 lb. per square inch general service air system around the plant is generally utilized.

Chemically the method is very efficacious and the largest bath can be thoroughly saturated with cuprous oxide in a couple of hours at small expense. The iron pipe used gradually dissolves, but the amount of iron thus absorbed by the copper is proportionately so small as to be of no consequence even in a cathode melting furnace.

SKIMMING

The next operation is the removal of the slag, which is simply pulled off with a rabble through the skimming door into suitable pots. The skulls are later broken up and if the slag made was reasonably fluid, the large amount of metallics always present can be easily sorted out and returned to the furnace. Often slag rich in metallics is returned to the next charge.

The general question of slag formation requires consideration at length and will be taken up later on.

COKING

When the bath has been skimmed to a clean face, charcoal, coke or anthracite coal is spread over the surface to protect it from oxidizing influences during the subsequent poling operation. At first charcoal was exclusively used, particularly when melting cathodes on account of its low ash and freedom from sulphur. Then the much cheaper low-sulphur coke crushed to suitable size was substituted, reserving charcoal merely for the covering on the pouring ladle between the furnace and the casting machine, where the finishing touches are always put in adjusting the oxygen content of the product. Finally buckwheat coal has been largely used on anode charges as the cheapest form of carbon for such work.

As this blanket of floating fuel burns away it has to be renewed so that no bare surface be exposed to possible oxidation.

POLING

As regards poling, as the reduction of the excess cuprous oxide is called, little or no change has been made from early practice. As the furnaces have increased in size larger and longer poles have been used, but the method of forcing one end of a pole below the surface of the bath by using a chain tackle making an inverted lever against an iron cross bar is still in use. As the pole is consumed it is gradually fed in and a new grip taken with the chain until the stick becomes too short, when it is thrown into the furnace as a floating brand. Green hard wood gives the best results.

The poling operation is a very clumsy one. The poles are hard to handle and bulky to store. When a single charge takes twenty-five young trees to pole it up it may readily be seen that the surrounding country will soon be stripped of suitable timber and that transportation charges make the poling cost an ever-increasing burden.

Oil poling has been tried with but partially satisfactory results. The reduction is very rapid when fuel oil is blown beneath the surface of molten copper, a few minutes' time corresponding to two hours' ordinary poling. In fact, its very rapidity of action is one of the objections to its use, as it is difficult to arrest the reducing action before the copper is "overpoled." Another serious difficulty attendant on the use of oil when poling cathode charges is that the copper absorbs sulphur or other impurities from the oil, which give a very curious appearance to its surface on cooling, and would doubtless make its sale difficult even if no objectionable property were imparted to it.

Finally oil poling is very variable in its expense. Apparently it is very easy to use twice the amount to pole one charge that is necessary for another, the excess oil being burned above the surface of the charge.

These difficulties have prevented the general use of direct oil poling. Nevertheless it seems probable that the time will come when gas poling will be used. It is evident that an outside source of heat can be used for the destructive distillation of wood or that oil or coal gas could be made suitable for the purpose. In the case of wood the cheapest available form of waste could be utilized instead of valuable young trees. Such a gas could be readily controlled in its action and a gas made from wood waste would require no purification.

As the poling operation proceeds sample buttons are frequently taken for examination, and when the desired amount of reduction as shown by these tests is nearly attained an ingot is poured and the nature of the "set" surface on the top of this casting inspected. When a full rounding surface is obtained the charge is ready to pour. Castings of different sizes require a different amount of unreduced oxide in order to obtain a level surface in an open mold. The final adjustment is therefore made in the casting ladle, where charcoal is added or allowed to burn thin according to the appearance of the set on the castings being made.

Should poling inadvertently be allowed to continue too long the charge becomes "overpoled," a condition the symptoms of which are much better understood than the underlying causes. The surface of a casting made from such copper swells as it cools until it breaks or "spews," giving a "worm" similar to that noted in connection with sulphur-bearing anode charges. While such a condition can be apparently rectified by a slight oxidation of the charge, copper in this state becomes unmanageable as regards its set, and such rapid vacillations are encountered while pouring that accepted practice is to flap the charge down again to "dry" copper and pole back to the proper oxygen content, or, in short, to re-refine the entire charge. The unstable condition can be controlled by adding certain substances, notably lead, in small quantities, but as mere traces of lead make copper brittle the cure is worse than the disease. It is probable that sulphur plays some part in this peculiar behavior.

POURING

Furnaces up to 20 tons in capacity used to be ladled by hand, a group of five or six men each with a ladle holding some 15 or 20 lb. of copper forming an endless chain between the "ladle hole" and the molds. The latter were made of cast iron or copper placed over a shallow bosh and the castings were dumped by hand into the water from which they were fished with suitable tongs. The next development was the "bull ladle," which is still in use at some places. This was simply a large ladle slung from an overhead crawl, enabling one man to dip out as much at a time as the five or six had done before.

Then came the casting machines, which have developed along several lines. Three general types are in use—the endless chain conveyor first developed by McCoy, the well-known Walker wheel and the variation of this known as the Clark machine.

The first, which has now gone out of use for wire bars, but is still occasionally employed for anodes and more recently in casting blister copper into pig, carried the molds on a link belt mechanism in front of the

spout, then lowered them on inclined rails into a bosh of water and then dumped the castings as the molds returned upside down on the return trip underneath the bosh. The Walker wheel, as its name implies, has a central hub carrying the rotating mechanism and radial arms supporting the molds. The Clark machine differs from the Walker chiefly in that the molds are carried parallel to the radial arms while on the latter they are placed circumferentially, and still further modifications have been made at the new Great Falls plant.

The Walker scheme has two advantages over each of the other types due to the way the molds are placed when casting wire bars. When the length of the mold is in line with the stream of copper there is a decided wash, which tends to make "splashes" and "cold sets" in the finished bar. Then in order to bring successive molds in line it is necessary to start and stop the machine, which jars the partially set castings just made and tends to make "edges," while the Walker wheel runs continuously, the pouring being done on the fly, so to speak. The lost motion and jarring of the link-belt type of machine was the chief reason for its abandonment in addition to higher maintenance costs. The Clark machine has the advantage that it will accommodate the giant wire bars supplied to a certain extent to foreign wire mills.

As the size of furnace began to outstrip even mechanical means for casting, always having in mind the desirability of completing a furnace cycle in an even twenty-four hours, the multiple-lip ladle was devised. In this way as many as four wire bars or eighteen ingots are poured at one movement of the intercepting ladle. Then came the twin ladle, and it was demonstrated that casting could be conducted at the rate of over 100,000 lb. an hour. This could again be doubled by using two wheels.

The bars are carefully inspected before shipment and any minor defects such as small "fins" cut off with a hammer and chisel. The temperature of the bosh water and also of the molds has much to do with the appearance of the finished product, although color due to slight films of oxide has not the importance attached to it to-day that was formerly the case. The bars should be dropped into the water as soon as possible after solidification is complete. The molds, which upset but do not enter the water and are sprayed to cool them, should retain a temperature just sufficient to enable them to thoroughly dry and properly take the bone ash wash which is applied to prevent the bars from sticking. On the other hand, the temperature of the bosh water itself must be held down by a circulating system to a point where it does not interfere with clear vision due to clouds of steam given off.

Various materials have been tried out as substitutes for the rather expensive bone ash used in painting molds. It is necessary that the substance used should have a high melting point, have no tendency to enter into chemical combination with molten copper, and particularly give off no gaseous constituent under heat which would tend to make the casting porous.

Lampblack serves the purpose, but is not readily applied. A smoked mold gives a beautiful casting. Pulverized silica is another substitute, but as the finish given is not entirely satisfactory its use is confined to anode work.

Bone ash should be thoroughly calcined to be free from grease, which evolves gases in the mold. A typical analysis of bone ash is:

$Ca_3P_2O_8$	97.69 per cent
LiO_2	1.01 per cent
MgO	1.02 per cent
Total	99.72 per cent

Many of the minor physical defects in refined copper can be traced to improper mold wash.

Another matter which needs attention is the chemical composition of the water used for cooling the copper. It is quite possible by constant evaporation coupled with an impure make-up water to obtain concentrations of sodium chloride and other salts which will crystallize out on the surface of the hot molds in sufficient quantity to cause pinholes in the bars.

The molds themselves can be made of either iron or copper, but the latter gives the best results. For many years molds were made by filling a built-up iron box with molten copper into which was thrust a core imprinting the desired shape. This method involves a complicated calculation of shrinkages starting with an iron mother core to produce a copper mother mold, which in turn makes copper cores from which the final molds are obtained. To-day this has been largely superseded by molding in sand with an ordinary wooden pattern.

A mold generally fails by burning or by warping. Spongy spots can be hammered up, but a mold should be discarded before any appreciable sponginess is found in the castings produced. Cracks in a mold tend to hold water which steams while the copper is being poured.

The general question of defects in refined copper and their causes will be discussed more in detail in a future article.

THE FURNACE CYCLE

A normal cycle for a large modern furnace would be about as follows:

Charging	3 hours
Melting to "flatness"	5 hours
Recharging	1 hour
Melting to "afloat"	5 hours
Blowing	2 hours
Skimming	1 hour
Poling	2 hours
Pouring	5 hours
	24 hours

The fire is grated and rebuilt during the charging period.

SLAG FORMATION

The amount of slag made naturally varies with the nature of the charge. It is a minimum when melting straight cathodes. The addition of wire mill scrap at once increases it. In the anode furnace we have in addition to blister copper, black copper, silver building slag, liberator tank residues, cement copper, secondary scrap copper and miscellaneous clean-up material.

It is possible to melt cathodes in a basic furnace and keep the slag made down to a small fraction of 1 per cent of the weight of the charge. In order to do this care must be taken to keep clay used for luting up the furnace doors from getting into the bath and the fire must be so managed as to blow as little coal ash over as possible as it increases slag by uniting with copper oxide.

On the other hand, a foul anode charge may make 20 per cent of slag and still represent good work. Representative slag assays are given in Table I.

TABLE I—REFINING FURNACE SLAG ASSAYS

Per Cent	Copper	Iron	Nickel	Insoluble	Lime	Sulphur	Arsenic
Anode slag	40.51	5.30	6.99	38.74	0.25	0.17	0.21
Wirebar slag	48.55	2.99	...	41.73	0.53	0.19	...

When nickel is present in quantity an infusible scoria is formed which carries with it a mass of metallics. Tin likewise forms a blanket of stannic oxide, which, however, can be fluxed.

Although the elimination of the elements occurs in the order of their oxidizability the separations are not sharp, and while a certain classification of impurities for further treatment can be roughly made, the losses in any such plan to separate lead, tin, zinc, etc., must necessarily be large, due to overlapping.

In the same way the copper slagged off carries with it some gold and silver. When anode assays over a period of time are compared with corresponding anode slag assays the silver appears too high. This is due to the large amount of silver brought into the charge in silver-building slags, which is not efficiently collected in the anodes but is passed on to the anode slag retreatment stage before it is again associated with the copper. Table II gives some assays where true comparisons can be made for both anode and wire bar furnaces.

TABLE II—RELATIVE SLAGGING OF GOLD AND SILVER

	Per Cent Copper	Oz. per Ton Silver	Oz. per Ton Gold
Anode slag	32.50	14.3	0.27
Anodes	99.44	81.48	2.299
Compensated slag assay	99.44	43.75	0.826
Slagging ratio	1.000	0.537	0.359
Wirebar slag	48.55	1.35	0.0140
Wirebars	99.94	1.40	0.0104
Compensated slag assay	99.94	2.76	0.0286
Slagging ratio	1.000	1.97	2.75

The surprising difference in the behavior of the wire bar furnace is due to the fact that the silver and gold in the cathodes is not alloyed with the copper but mechanically entangled as wandering anode slimes. Upon fusion some of this slime floats and is skimmed off with the slag. It is not all released, however, as we see not only by direct assay of the wire bars but from the lowering of electrical conductivity by one or two per cent when wire bars are compared with cathodes.

The general question of making anodes from foul material will be reserved for treatment in a separate article.

THERMAL EFFICIENCY OF THE REFINING FURNACE

The coal consumption of a large modern refining furnace under average operating conditions is about 12 per cent of the good product made. As the coal used in obtaining this figure runs about 13,750 B. T. U. per pound the heat requirement is 13,750 x 0.12 or 1650 B. T. U. per pound of copper produced.

If we take the mean specific heat of copper at 0.11 and the latent heat of fusion as 80 B. T. U. per lb. and assume that copper is charged at 70 deg. F. and poured at 2170 deg. F. we have the net heat input required 0.11 x 2100 + 80 or 311 B. T. U. per lb., giving an efficiency of 311 ÷ 1650 or about 19 per cent. Waste heat boilers now recover heat equivalent to at least 6 lbs. water from and at 212 deg. F. per lb. coal burned in the furnace. This is equivalent to 966 x 6 x 0.12 or 696 B. T. U. per lb. of copper, bringing the overall thermal efficiency up to 1007 ÷ 1650 or about 61 per cent.

It will therefore be seen that operating as a simple reverberatory the furnace is very wasteful but that when there is a demand for steam the combined furnace and boiler is nearly as economical of heat as would be an electric furnace. The general question of waste heat boilers will be dealt with in a later article.

RETREATMENT OF SLAGS

Slags made from normal anode and refining furnace charges require reduction with the substitution of another base to free the copper. As the slags from cathode charges carry very small values in gold and silver they are sometimes kept separate from the anode slags and the copper recovered therefrom made into casting copper in order to avoid the cost of passing this metal through the anode furnace and tank house steps of the process.

The simplest means of reduction is a small blast furnace operated with limestone and pyrites cinder as fluxes and making black copper as a product. A furnace much smaller than 44 in. x 66 in. gives trouble in keeping the crucible open and as even this small size has a capacity in excess of the requirements of most refineries, it is often necessary to run intermittent campaigns.

If true black copper is made—say 97 per cent copper carrying considerable iron—a very bad slag is inevitable, the copper running 2 or 3 per cent therein. As a rule there is enough sulphur in the iron flux used to produce a little matte, and a copper running about 94 per cent and a slag of 0.6 per cent is made. This product delays the work in the anode furnace unless it is systematically charged back day by day, as small quantities of sulphur take some time to blow out of an anode charge.

Where a smelter is operated in conjunction with a refinery, these furnace slags are usually added to the ore charge. The reducing action in a matting furnace is hardly strong enough to thoroughly decompose these high grade silicates and a noticeable increase in oxidized slag losses always follows their addition to the charge.

They are also very difficult to accurately sample on account of the metallics contained and the refinery will suffer and the smelter correspondingly gain unless special supervision is exercised over this sampling, as the workmen naturally avoid metallics in taking the sample as they give such trouble in the crushing.

Finally nothing is gained in cost by matting these slags, as the advantage of the larger scale of operation and somewhat lower slag losses is offset by the sampling costs and complication of adding sulphur to this high grade sulphur-free material only to blow it out again in the succeeding converting operation. The anode furnace gains somewhat however in not having any low grade black copper to treat.

FUTURE DEVELOPMENTS

Great progress has been made in the development of the refining furnace and not much remains to be done along purely structural and mechanical lines. In twenty years the 24-hour charge capacity has been changed from 20 tons to 250 tons and furnaces of greater capacity could easily be built were there any

justification for it. The copper is handled mechanically both in and out of the furnace. The hearth is now constructed of magnesite brick when a corrosive charge is to be handled. The walls and verb and sometimes the entire roof are now built of chrome brick to withstand the copper oxide wash.

In firing the furnace there is yet some room for progress, but when it is considered that an open hearth steel furnace takes four times as much fuel per ton of product, it will be seen that there is not the same justification for expensive gas firing equipment. Either oil or gas firing may be successfully applied, however, and commercial factors may some day call for their introduction. The poling operation as already pointed out will doubtless in time be replaced by gas reduction.

Metallurgically the anode operation is quite satisfactory. The melting of cathodes is not in such good shape, however, as here what should be a simple melting is expanded into a complete refining. This has been attacked in two ways—by the use of the electric furnace and by continuous melting.

The electric furnace is not very promising as it has already been shown that with a waste heat boiler attached the heat efficiency of the reverberatory is high enough to give electric heat from steam driven generators a hopeless handicap. Then the high electrical conductivity of copper, the shape of the cathodes to be melted and the necessity of having the product absolutely free from bits of charcoal or other resistor material, introduce limitations in the design of the furnace.

It must also be remembered that there is a slight refining done in melting cathodes as shown by the concentration of impurities in the slag as well as the effective elimination of sulphur brought in as entrained sulphates from the electrolyte.

Continuous melting is more attractive. The method already described of charging large quantities of cathodes during pouring and carefully excluding all acid material from contact with the bath to avoid the formation of slag has been for some years in successful use and might be called semi-continuous melting. It is obvious that the principle could be extended until the amount charged just balanced the amount poured, but this requires slow casting rates in order to keep the heat up and introduces some practical difficulties. The sulphur is controlled in this method by inserting piles of cathodes which do not fully submerge in the molten bath. This gives the opportunity for a little oxidation of the exposed sheets before the mass softens and becomes immersed.

Various patents have been issued for plans which virtually combine a blast furnace melting with a reverberatory fore-hearth. Copper is so readily contaminated by contact with products of combustion, etc., however that it is difficult to apply methods of direct melting without having to go through a large part of the regular furnace treatment afterwards.

Perhaps the weakest point in the present reverberatory practice lies in the system of utilizing labor. Custom has placed a crew in charge of each furnace. Originally a night crew did the melting and rabbling and some of the poling while the day crew would attend to the ladling and charging. As a number of men were required for hand ladling this fitted in with the heavy work of charging. All the furnaces were supposed to be ready to cast early in the morning and the crew kept hours depending upon the furnace which would generally get progressive—later during the week, the over Sunday period being used to catch up.

When mechanical ladling was introduced it became necessary to organize special labor gangs to assist in the charging of the furnaces which now were much larger and with a reduced ladling crew.

Mechanical charging, however, eliminated this trouble and the necessary crew for handling a furnace is very small. The old system is therefore beginning to give way to one where instead of operating in unison the furnaces are intentionally staggered. In this way they may be skimmed one after another, for example, and a casting crew can be organized who will go from one furnace to another and be replaced by a new shift at a predetermined hour, making the men entirely independent of the behavior of individual furnaces. When this is fully accomplished furnace work will become a less arduous and less specialized occupation.

Recovery of Sulphur from Illinois Coals

By Joseph E. Pogue

Illinois coals contain from 1 to 6 per cent of sulphur. This is present chiefly in the form of a brass-yellow metallic mineral, known technically as pyrite or marcasite, but called commercially "coal-brasses" and termed by the miners "sulphur." This material occurs as small seams, lenses, and nodules scattered through the coal, and is generally looked upon as an objectionable impurity, because it must be removed before the coal is marketed. As a matter of fact, however, this so-called impurity is a raw material of value for the manufacture of sulphuric acid, and its worth at present is from three to four times as great as that of the coal itself. Its recovery, therefore, in those mines in which it is now thrown aside affords a good opportunity for turning a troublesome waste product into profit and thus establishing a new source of revenue with little added effort. Into such strong demand has pyrite come that there is even a possibility that some mines, abandoned because of the unusually high sulphur content of their coal, may be reopened and successfully operated as pyrite producers, with coal as the incidental or by-product.

A few of the Illinois coal mines for a number of years have been recovering their pyrite and selling it to nearby chemical works; but the output of the entire State for any given year has never exceeded 27,000 long tons, and the total value of the pyrite produced from 1907 to the present in round numbers amounts to only $400,000. These figures fall far short of the possibilities of the State in this respect. With a coal production around 60,000,000 tons a year and pyrite worth upwards of $8 a ton, the Illinois coal fields have the opportunity of greatly extending their pyrite yield and of building up a substantial by-product industry around this mineral.

The time is unusually favorable for doing this. Conditions growing out of the world war have created an unprecedented demand for pyrite. Before the war, the United States was producing about 3,500,000 tons of sulphuric acid per year, nearly two-thirds of which was made from pyrite imported from Spain. The extraordinary impetus given to chemical manufacture by the war

needs of the Allied Governments has succeeded in largely increasing our sulphuric acid requirements, while the submarine campaign has cut off a large share of the Spanish ore and endangered the meager supplies still being received from that source. The situation, therefore, is serious and even critical; for sulphuric acid is not only esential to the manufacture of explosives and fertilizers, but is required in practically every chemical industry, and in consequence underlies the whole fabric of our industrial life. An impaired sulphuric acid production would be fraught with the most serious industrial consequences. The pyrite situation reached its climax during the past few months, and a realization of the importance of this matter has created a lively activity on the part of both American industry and the Government to develop sufficient domestic raw materials to meet the current sulphuric acid needs before the pyrite reserves on hand become exhausted or the Spanish mines be completely barred.

There are four domestic sources of materials suitable for the manufacture of sulphuric acid. These must not only be looked to to tide over the present emergency, but they also have the opportunity of establishing under present circumstances an enlarged output which can replace part at least of the Spanish supply in the period succeeding the war. The first of these sources is included in the many small deposits of pyrite and related sulphides scattered through the Eastern States. These were formerly unable to compete with the Spanish ore, brought to this country cheaply as ballast by Mediterranean freighters; but now, enlivened by favorable prices, they are contributing an appreciable tonnage to acid plants. The second source is formed by the fumes of many smelters, chiefly in the Western States, formerly allowed to go to waste, but now turned into acid. This was the most important domestic source of sulphuric acid even before the war, and is now producing at an increased rate; but it is incapable of meeting the situation alone, not only because unable to produce a sufficient tonnage, but more especially because costly freight hauls wall off the eastern and mid-western manufacturing centers. The third source is the large deposits of native sulphur at Sulphur, Louisiana, and Bryan Heights, Texas, which produce a very pure product, too highly priced under normal conditions to compete with pyrite, but which may be drawn upon to meet the pyrite shortage during the present emergency. The final source is the pyrite or "coal-brasses," partly saved but largely wasted, in connection with bituminous coal mining, a source capable of considerable enlargement, particularly in Illinois where the pyrite content of the coal in many localities is sufficiently great to afford significant quantities of this valuable and desirable material.

The State Geological Survey desires to bring to the attention of the coal-mining interests of Illinois the urgency of the pyrite situation, with the hope that the pyrite possibilities of each mine will be given careful consideration. It is believed that if pyrite be recovered from all mines in Illinois in which it may be produced at a profit, the output of the State will be raised to a significant figure, a paying side-industry will become permanently attached to the mining of coal, and much-needed assistance will be rendered the United States in the present military emergency.

To those operators who are interested in the commercial possibilities of pyrite recovery, reference may be made to a publication by E. A. Holbrook, issued by the Engineering Experiment Station of the University of Illinois, dated August 20, 1917, and entitled, "The Utilization of Pyrite Occurring in Illinois Bituminous Coal," copies of which may be obtained by addressing the State Geological Survey, Urbana. This paper gives detailed specifications, based on careful experimental tests, for a simple mill, which may be installed at an approximate cost of $18,000, capable of producing from hand-picked material 50 tons of commercial pyrite per 8-hour day, at a profit of $1.50 a ton.

The State Geological Survey is seeking to bring the matter to a head at the earliest possible moment and is therefore sending a representative to the principal coal districts in which pyrite is known to occur in significant quantity. He will be prepared to furnish a list of the available markets and the requirements which the material must meet to be accepted for acid manufacture; to discuss the general industrial situation in regard to pyrite, with special reference to the opportunities for continued development after the war; to furnish specifications of mill installation for handling the product; to gather data for estimating the total pyrite possibilities of the State; and in general to render such assistance toward stimulating production as lies within the power of the State Geological Survey.

The need is urgent for an increased pyrite production in the United States. The opportunity is present for enlarging the output in Illinois. A response to the present situation will result not only in profit to the coal mining industry of the State, but will constitute an important contribution toward solving one of the most critical resource problems faced by the nation today.

But the issue is even more far-reaching than that involved in the opportunity of profit or even of patriotic service. It is becoming more and more evident that the best interests of any industry lie along the line of co-ordinated development, not only of all possibilities within itself, but of all points of contact with other industrial activities as well. Industrial aloofness is becoming as impossible of economic justification as is national isolation. The establishment on a firm basis of a by-product development in conection with coal mining assumes in this light, an importance out of proportion to its measure in tonnage or value involved. To add a new facet to the Illinois black diamond may not complete its brilliance, but it will augment its luster.

State Geological Survey,
Urbana, Illinois.

Chicago Companies Foregoing Holiday Cards

A number of companies in Chicago, including the large steel companies, have this year decided not to distribute holiday greeting cards but to give the money formerly spent for this purpose to war-relief organizations such as the American Red Cross, American Fund for French Wounded, etc. Among the companies which are doing this are the following: Illinois Steel Company, Morden Frog & Crossing Company, American Steel & Wire Company, Universal Portland Cement Company, Lackawanna Steel Company, Carnegie Steel Company, Inland Steel Company, Chicago Railway Equipment Company, A. M. Castle & Company, The P. & M. Company, A. J. O'Leary & Son Company.

Laboratory Methods for Benzol-Recovery Plant Operation—II

By F. W. Sperr, Jr.
Chief Chemist, H. Koppers Co.
(*Continued from Page 555*)

Method for the Boiling Point Tests of Benzols

An interesting article could be written descriptive of the evolution and standardization of the boiling point test which is in universal use by all makers and users of the various benzols. It is not, however, our purpose to do this, but we shall simply give the details of the method that we are employing at present, in the belief that some of these details—which have hitherto been omitted in the descriptions of this method published in various American books and journals—may be found in convenient form to include in standard specifications.

The European method—which is referred to two or three times in our description—may be found in Lunge's "Coal Tar and Ammonia," fourth American Edition, p. 755. The American method was described about six years ago by S. R. Church (*Jour. Ind. Eng. Chem.*, 1911, p. 227, V. Drawing No. 8, p. 232). A number of modifications have since been more or less widely adopted, such as the substitution of the standard Engler flask for the 200 cc. Jena flask, and it is probable that the most up-to-date description of the method is that given in the Gas Chemists Handbook, recently published by the American Gas Institute (p. 180). It is stated that the method in the Handbook is adapted with some modification from the report of Sub-Committee D-1 A. S. T. M., 1915. In the notes appended to our description, reference will be made both to the A. G. I. and the A. S. T. M. committee report.*

After experience with both the European and the American methods, there can be no hesitation in affirming that the latter is superior, but it still suffers the fault that many of its essential details have not been standardized with sufficient precision.

FLASK

The flask used shall be the standard Engler flask, as described in various standard works upon petroleum such as Redwood, Hole, etc. The flask is of globular shape 6.5 cm. in diameter, with a cylindrical neck 1.6 cm. in internal diameter, and 15 cm. in length. Half way up the side of the neck a vapor tube of not less than 5 mm. diameter and not less than 10 cm. nor more than 12 cm. in length extends at an angle of 75 deg. downward to the condenser. The junction of the vapor tube with the neck of the flask is 9 cm. above the surface of the oil when the flask contains its charge of 100 cc. of oil.

Notes: Redwood's description, as quoted by the A. G. I. and the A. S. T. M., omits the position and diameter of the vapor tube, both of which are important. With a vapor tube too long or too constricted in diameter, a pressure is produced within the flask during distillation, which has a material effect on the boiling point.

CONDENSER

The condenser tube, see Fig. 5, shall consist of a straight piece of thin glass 24 in. in length, having an inside diameter of ½ in. throughout. There shall be no constrictions or irregularities in the condenser tube. The tube shall be fitted with a 15-in. jacket having connections for cold water. The tubulature of the distilling flask shall be inserted through a tightly fitting cork 2 in. into the condenser tube.

Notes: A. G. I. specifies tube of thin glass 24 in. in length. Does not specify diameter of tube nor length of jacket. One form of condenser is objectionable because the enlarged adapter holds a small amount of benzene and cannot be thoroughly drained in the position shown. The side neck of the distilling flask should project some little distance beyond the cork instead of being flush with the cork. The A. S. T. M. condenser is of the trough type 15 in. long, having a tube of thin brass ½ in. internal diameter by 22 in. long. The lower end of the condenser is cut off at an acute angle and is curved down for a length of 3 in., so as to project at least ½ in. into the 100-cc. cylinder used as a receiver. A pasteboard cover should be placed over the top of the cylinder and surrounding the condenser tube. The choice between the trough and the ordinary Liebig condenser jacket is simply a matter of personal preference. The same is true of the choice between glass and brass for the condenser tube. In using the trough, arrangements should be made for continuous circulation of water. In benzol work it is not necessary to have the end of the tube curved, as recommended by the A. S. T. M., and the straight tube considerably facilitates cleaning.

BURNER

A standard Bunsen burner having separate adjustments for regulating the supply of gas and air shall be used. The opening at the top of the burner shall be 5/16-in. diameter. When making distillations the flame of the burner must be so regulated as to be blue at any portion of the top.

Notes: A. G. I. and A. S. T. M. give no specifications. The burner recommended is the one most commonly used in this work. The specification regarding the character of the flame is borrowed from European specifications, and is good practice, since a smoky flame may give unsatisfactory results.

FURNACE

The flask sits on an asbestos slab ⅛ in. thick and 6 in. square, having a circular hole 1 in. in diameter in its center. The furnace is cylindrical in shape, 5 in. in diameter and 8 in. tall. It has four round holes—1 in. in diameter—equally spaced around the top, lo-

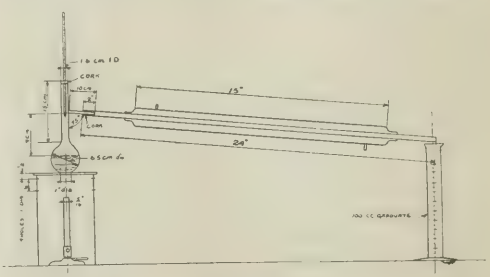

FIG. 5. CONDENSER ARRANGED WITH FLASK AND RECEIVER

*See also the recently published Standard Method for Testing Paint Thinners other than Turpentine—A. S. T. M. standards adopted in 1917, p. 7.

cated ½ in. below the top, for the escape of products of combustion.

Notes: A. G. I. specifies a 1½-in. opening in the asbestos. A. S. T. M. specifies a 1¼-in. opening. The Barrett Company's laboratories have found a 1-in. opening much more satisfactory, and our own tests confirm this. The following comparisons may be of interest:

Using a 1½-in. opening in the asbestos flame guard.

	Jena Flask	Engler Flask
First drop	79.72	79.65
5%	80.12	80.15
10%	80.22	80.25
20%	80.32	80.27
30%	80.32	80.30
40%	80.32	80.33
50%	80.32	80.35
60%	80.32	80.35
70%	80.33	80.35
80%	80.37	80.35
90%	80.42	80.45
Dry	81.02	81.25

Using a 1 inch opening in the asbestos flame guard.

	Jena Flask	Engler Flask
First drop	79.87	80.01
5%	80.22	80.33
10%	80.34	80.35
20%	80.36	80.36
30%	80.36	80.36
40%	80.36	80.36
50%	80.36	80.36
60%	80.36	80.36
70%	80.36	80.36
80%	80.37	80.36
90%	80.38	80.37
Dry	80.41	80.44

It can readily be seen from the above figures that the 1-in. opening is the better size for the following reasons:

1. With a 1-in. opening it is difficult to drive over the first drop too rapidly, and different operators will not vary greatly.

2. It is almost impossible to run the distillation too fast.

3. With only a 1-in. opening the dry point is much easier obtained, as the tendency to superheat is greatly reduced.

The shield recommended by the A. G. I. Handbook is unsatisfactory because it would be almost impossible to determine the "dry point" satisfactorily.

The one recommended by A. S. T. M. is rather cumbersome.

The shield above recommended is copied after European practice and has always given very good results.

RECEIVER

An ordinary 100-cc. graduate (graduated in 1 cc.) is used for the receiver. Graduations must be clear cut and distinct. The graduate should be approximately 1 in. in diameter. The mark for each 10 cc. should be longer than the intermediate markings and should be plainly numbered.

Notes: This is essentially the same as specified by the A. G. I. and the A. S. T. M., but the specifications have been made more definite.

THERMOMETER

All distillation thermometers shall be made of resistance glass of a quality equivalent to suitable grades of Jena or Corning makes. They shall be thoroughly annealed. They shall be filled above the mercury with inert gas which will not act chemically on nor contaminate the mercury. The pressure of the gas shall be sufficient to prevent separation of the mercury column at all temperatures of the scale. There shall be a reservoir above the final graduation large enough so that the pressure will not become excessive at the highest temperatures. The thermometer shall be finished at the top with a small glass ring or button suitable for attaching a tag. Each thermometer shall have —for identification—the maker's name and a serial number.

For the boiling determination of crudes and solvent naphthas the thermometer shall be graduated from 0 deg. to 400 deg. C. at intervals of degrees Centigrade. Every fifth graduation shall be longer than the intermediate ones, and every tenth graduation beginning at zero shall be numbered. The graduation marks and numbers shall conform to the following dimensions:

Total length, mm.	385 maximum
Diameter of stem, mm.	7, tolerance 0.5
Diameter of bulb, mm.	5 minimum and shall not exceed that of stem
Length of bulb, mm.	12.5, tolerance 2.5
Distance 0 deg. to bottom of bulb, mm.	30, tolerance 5
Distance, 0 deg.-400 deg.	295, tolerance 10

The accuracy of the thermometer when delivered to the purchaser shall be such that when tested at full immersion the maximum error from 0 deg. to 200 deg C. shall not exceed 0.5 deg.; 200 deg.-300 deg. C., it shall not exceed 1 deg. C.; 300 deg.-375 deg. C., it shall not exceed 1.5 deg. C. The sensitiveness of the thermometer shall be such that when taken at a temperature of 26 deg. C. and plunged into a free flow of steam the meniscus shall pass the 90 deg. C. mark in not more than 6 seconds.

For the boiling determination of pure benzene and pure toluene the thermometer shall be graduated from 70 deg. to 120 deg. C. at intervals of 1/10 deg. C. Each graduation for half degrees shall be longer than the intermediate ones, and each degree beginning at 70 deg. C. shall be numbered. The graduation marks and numbers shall be clear cut and distinct. The thermometer shall conform to the following dimensions:

Total length, mm.	460 maximum
Diameter of stem, mm.	7, tolerance 0.5
Diameter of bulb, mm.	5 minimum, and shall not exceed that of stem
Length of bulb, mm.	12.5, tolerance 2.5
Distance 70 deg. C. to bottom of bulb, mm.	95, tolerance 5
Distance, 70 deg. C. to 120 deg. C., mm.	330, tolerance 10

The thermometer, when delivered to the purchaser, shall be furnished with a calibration sheet by the maker, with corrections at 80 deg. C. and 110 deg. C., together with the difference between the expansion of the mercury and glass used, for making correction for emergent stem. All thermometers shall be calibrated for total immersion.

Notes: The thermometer for the determination of crude materials is the same as specified by the A. G. I., and has some slight differences from the A. S. T. M. description. It is necessary in addition to this to have a very accurate thermometer for tests of pure benzols. We have found the thermometer described above to be very much more satisfactory than the one described on

p. 187 of the A. G. I. Handbook. Most specifications for pure benzene call for a range of 2 deg. A single interval on the scale of the A. G. I. thermometer amounts to 10 per cent of this range, and the graduations are so close that it is difficult to interpolate satisfactorily.

METHODS OF DISTILLATION

The flask, connected with the condenser, shall be filled with 100 cc. of the material at 15.5 deg. C., which shall be measured in the 100 cc. receiving cylinder. The same cylinder may be used without drying as the receiving vessel for the distillate. The thermometer shall be inserted through a tightly fitting cork in the neck of the flask so that the top of the thermometer button will be on a level with the bottom of the side outlet in the neck of the flask and in the center of the neck. The distillation shall proceed at a rate of not less than 4 nor more than 5 cc. per minute into the receiving cylinder. The flask must be heated very slowly just before the first drop comes over in order that the thermometer will register the correct temperature. The temperature at which the first drop leaves the end of the condenser shall be considered the initial boiling point. In testing pure benzols and refined naphthas, the distillation shall be continued until the last drop is vaporized, when a puff of white vapor usually appears in the bottom of the flask. The temperature at this point shall be considered the end or dry point of the distillation. The total yield of distillate shall not be less than 97 per cent.

Notes: In making tests of pure benzene, toluene, xylene and refined naphthas, it is our practice to record the following temperature readings: First drop, 5 per cent, 10 per cent, and each 10 per cent thereafter to the dry point. The intermediate readings may be omitted at discretion, but often serve a useful purpose in benzol plant operation. In tests of light oils, it is our practice to record the following readings: Temperature of the first drop and per cent distillate at the following temperatures: 80 deg. C., 95 deg. C., 100 deg. C., 120 deg. C., 150 deg. C., 180 deg. C., 200 deg. C. In case the dry point should come before any of the above temperatures are reached, this is recorded and the distillation discontinued. Doubtful products and residues are distilled in a 200-cc. glass flask similar to Fig. 3, p. 556, using a 100-cc. sample and a thermometer having a range between 70 and 400 deg. C. Temperatures are recorded for the following: 5 cc., 10 cc., 20 cc., 30 cc., 40 cc., 50 cc., 60 cc., 70 cc., 80 cc., 90 cc., 95 cc. In case of the still residues, the distillation is stopped when the oil beomes extremely thick and viscous. In making boiling-point tests of refined or pure benzols it is often important that corrections for emergent stem and barometric pressure be made. (In the case of crude materials this is not so essential.)

EMERGENT STEM CORRECTION

Let C = Number of degrees Centigrade to be *added* to the observed temperature.
N = Number of degrees of the stem exposed.
T = Average temperature of the bulb.
t = Average temperature of the stem.
K = Correction factor for the thermometer (*i.e.*, the difference between the coefficients of expansion of mercury and glass).

Then: $C = KN\ (T-t)$.

For example:

Observed temperature	= 80 deg. C.
Steam temperature	= 25 deg. C.
Degrees emerging (from top flask to 80 deg. C.)	= 15 deg. C.
Thermometer coefficient	= 0.000154
80 deg. C. — 25 deg. C.	= 55 deg. C.
15 deg. x 55 deg. x 0.000154	= 0.12787 = 0.13 deg. C.
Temperature corrected for emergent stem	= 80.13 deg. C.

BAROMETRIC PRESSURE CORRECTION

The difference of temperature for each millimeter between 720 mm. and 780 mm. is in the case of:

Benzene	0.043
Toluene	0.047
Xylene	0.052
50 per cent Benzol	0.0461
90 per cent Benzol	0.0453

For example:

If barometer reading is 754.7 mm. (at 0 deg. C.) and thermometer (corrected for emergent stem) is 80.13 in the case of benzene:

760 — 754.7 = 5.3 mm.

0.043 × 5.3 = 0.2279 = .23 deg. C. to be added.

80.13 deg. + 0.23 deg. = 80.36 deg. C. corrected temperature.

Note: It must be borne in mind that if the barometer reads above 760 mm. the barometric correction must be subtracted.

Exports of American-Made Dyestuffs from the United States

The new classification used since the beginning of the current fiscal year by the Bureau of Foreign and Domestic Commerce in its monthly statements of domestic exports shows separately for the first time the item of aniline dyes. For the month of July the shipments of American-made aniline dyes from the United States to foreign countries amounted to $497,106.

Of all the industries created or developed as a direct result of war conditions, none has shown more rapid progress than American dyestuffs. From only seven establishments, in which 528 people were engaged in producing 6,619,729 pounds of coal-tar colors, valued at $1,126,699 in 1914, the industry has developed until now it not only supplies the domestic demand for colors, but also part of the foreign market.

Articles, and Countries to which Exported	July —		Seven Months Ending July—		
	1916	1917	1915	1916	1917
Dyes and dyestuffs	$687,555	.....	$1,270,251	$4,084,343	*$7,153,689
Aniline dyes	.....	$497,106	.....	.....	†497,106
Logwood extract	.....	205,024	.....	.....	†205,024
All other	.....	576,579	.....	.....	†576,579
Total, dyes and dyestuffs	$687,555	$1,278,709	$1,270,251	$4,084,343	$8,432,398
Exported to—					
France	$30,139	$203,691	$18,152	$237,558	$505,784
Italy	29,662	66,854	237,662	610,531	1,103,900
Russia in Europe	56,875	.....	5,922	333,994	57,683
Spain	22,031	100,170	13,814	175,586	779,497
United Kingdom	128,753	363,527	439,187	483,458	1,924,325
Canada	135,442	80,551	347,733	1,190,655	997,337
Mexico	2,689	34,729	413	99,697	413,114
Argentina	22,696	43,610	25,400	134,457	214,941
Brazil	30,820	152,414	3,862	95,040	954,109
British India	.....	117,608	577	93,048	408,750
Japan	27,924	36,156	98,244	132,863	416,239
Other countries	200,518	79,399	79,285	497,416	656,719

*Figures cover period from Jan. 1 to June 30, 1917. †July only.

Influence of Temperature on the Electrical Resistivity and Thermo-Electromotive Potential of Steels*

By Edward D. Campbell†

It is now more than a century since Proust, in France, first stated that white cast iron should be regarded as a solidified solution of carbides of iron in iron, and more than a half century since Matthiessen, in England, also maintained that steel and other alloys should be considered as solid solutions, the electrical properties of which are dependent upon the chemical composition. The solution theory of metals is now nominally accepted by most metallurgists and physicists and yet the question may be raised as to how many experimenters have accepted the essential unity of mechanism of metallic and aqueous solutions, and have based their experimental work on this conception.

In studying the properties of ordinary solutions the part played by the solvent is clearly differentiated from that played by the solutes. It is those solutes which are in solution that are capable of reacting with electrical energy transporting it as an electric current or with radiant energy such as light-producing absorption or refraction. In 1915 (*Journal* of Iron and Steel Institute, 1915, No. II, page 164) the author brought forward experimental evidence to show that the electrical resistivity of steels is a function of the concentration of the carbides or other solutes in solution. A year later (*Journal* of Iron and Steel Institute, 1916, No. II, page 268, and *Transactions* of the Faraday Society, Vol. XII, 1917, page 274) the dependence of the electrical resistivity on the concentration of the solutes was confirmed; and it was further shown that if carbides are the only solutes present the thermoelectromotive potential of these carbides is also a function of the concentration. The hypothesis was advanced at that time that it is the molecules of solutes in solution which are capable of reacting with electrical energy transforming it into heat, thus causing electrical resistivity. Electrical conductance seems to take place almost wholly through the solvent, while the total resistivity seems to be made up of two components—first, that portion due to the solvent, and, second, that due to the solutes in solution. It has been known for many years that the temperature coefficient of electrical resistivity of nearly all strictly pure metals is approximately constant between 0 deg. C. and 100 deg. C., while the temperature coefficient of impure metals and alloys is always lower than that of pure metals, often being very small or even negative. In determining the temperature coefficient of resistivity it is customary to determine the specific resistance of the metal as a whole at two or more temperatures and calculate the change in specific resistance to a percentage basis of the specific resistance at a standard temperature. No attention is paid to the solution theory of metals, for the real acceptance of this conception would require that the total specific resistance be regarded as made up of two components—first, that due to the solvent, and, second, that due to the solutes, with the presumption that the laws governing the two portions might differ.

If, under the solution theory, the total specific resistance is to be regarded as made up of two components, it would be only reasonable to expect that under the same conception the thermoelectromotive potential of a metallic solution might also be regarded as made up of two components—that due to the solvent and that due to the solutes in solution.

The principal objects of the present investigation, the laboratory work of which was carried on by William C. Dowd, M.S., were to bring forward some further experimental evidence of the essential unity of mechanism of metallic and aqueous solutions and to show that while the electrical properties of metals are dependent upon the chemical constitution, the effect of changes in temperature of measurement on that portion of the properties due to solvent are not the same as those controlling that portion due to solutes in solution.

EXPERIMENTAL

Steel is one of the best materials with which to study the solution theory of metals because the solvent iron is capable of existing in at least two allotropic forms, and certain solutes, noticeably carbides, are quite readily soluble in iron in the *gamma* condition, although only slightly soluble in *alpha* iron. It is the difference in the solvent and dissociating power of iron in its various allotropic forms that enables the concentration of certain solutes, particularly carbides, to be controlled by heat treatment; thus modifying the chemical constitution without change in the ultimate composition. The stock samples of steels used in the present research were furnished by the courtesy of the American Rolling Mill, the Bethlehem, the Carpenter, the Halcomb and the Midvale Steel Companies, and have the composition shown in Table I, in which the steels are arranged in order of the carbon content.

TABLE I.

Steel.	Carbon, per Cent	Manganese, per Cent	Phosphorus, per Cent	Sulphur, per Cent	Silicon, per Cent	Copper, per Cent	Nickel, per Cent	Chromium, per Cent	Tungsten, per Cent
INI	0 018	0 016	0.005	0 018		0.018	....	.....	.....
SN3	0.104	0.122	0 03	0.025	3 649			.....	.....
M8	0.326	0.405	0 013	0.026	0.162	. ...	4.48	.....	.....
H12	0 61	0.25-0.35	0 020	0 020	0.20-0.30	.....	....	0.20-0.30	5 00-5.25
C5	0 945	0.189	0 013	0.016	0.155	. .	....	.....	.....
SN1	1.11	0 40	0 020	0 038	1.20	0.06	0.31	0.348	.....
MN1	1.15	11.57	0 055	0.023	0.25	....	....	.....	....
INC	1.18	0.016	0.005	0.018	. . .	0.018	....	....	...

With the exception of the sample marked INC, stock samples of all the steels were annealed by heating over night in an electrically heated furnace to the temperature given in each case and allowing the steel to cool with the furnace for twenty-four hours. From the stock bars, which were thus very carefully annealed under conditions which would completely prevent oxidization, small experimental bars 6 millimeters square and 15 centimeters in length were machined out. These experimental bars were used for studying the influence of heat treatment on the electrical properties.

The sample marked INC was prepared by carburizing small bars of INI, twelve of these small bars being carefully packed in a carburizing mixture made up of one-fourth barium carbonate, one-fourth animal charcoal and one-half wood alcohol. The muffle containing the bars packed in the carburizing mixture was heated over night in an electrically heated furnace, the maximum temperature reached the next day being 969 deg. C. The temperature was then maintained for two days between 960 deg. C. and 945 deg. C., allowed to cool

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over night to 845 deg. C., maintained one day at 845 deg. C., and the next day held between 820 deg. C. and 800 deg. C., after which the furnace was allowed to cool to room temperature. Analysis of the bars showed 1.18 per cent carbon, and a micro-section showed that carburization had proceeded through the entire bar; in fact, the excess cementite tended to be more marked in the center than near the periphery of the bars.

In order to harden the steels, bars were suspended in an electrically heated furnace which had been previously brought to the temperature from which it was desired to quench. The furnace was so arranged that the bars could be suspended in it for an indefinite length of time without any oxidation taking place. The bars were kept in the furnace for one hour to ensure their attaining the same temperature as that of the furnace, which was measured by means of a standard platinum-rhodium thermocouple, placed within two or three millimeters of the bars. When the bars had come to constant temperature they were withdrawn from the furnace and quickly cooled in a large volume of iced water. The time required to transfer a bar from the furnace to the cooling bath, taken with a stop-watch, averaged four-fifths of a second. The time required to cool from the quenching temperature to a black heat outside was from four-fifths of a second to one second, and until the bars reached the temperature of the cooling bath from five to six seconds. During the time the bars were being transferred from the furnace to the quenching bath a film of oxide was formed on the surface, but this was so slight as to constitute only a discoloration.

When the bars had been quenched they were carefully polished and measurements made of the specific resistance at 25 deg. C., and of the thermoelectromotive potential over a temperature gradient of 0 deg. C. to 25 deg. C., the freshly quenched bars being opposed to annealed bars of the same steel. Since it was desired to study the influence of temperature of measurement on the specific resistance and thermoelectromotive potential of the steels and since the solid solution in freshly quenched steel is distinctly unstable, it was necessary to bring these steels to a state which would be fairly stable at temperatures up to 100 deg. C. This was done by placing the freshly quenched bars, after the measurements of specific resistance and thermoelectromotive force at 25 deg. C. had been made, in an electrically heated drying oven maintained at 105 deg. C. and allowing the bars to temper at this temperature from two to three days. After tempering at 105 deg. C. in this way measurements of the specific resistances were made at 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C., and also of the thermoelectromotive potentials over the temperature gradients 0 deg. C. to 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C., the tempered bars being opposed to annealed bars of the same steel.

The resistivities were determined by measuring the fall in potential between knife-edges clamped to the bar 10 centimeters apart, while a current of constant density was flowing through the bar. The fall of potential was compared with that given by a standard resistance which had been calibrated by means of a Siemens and Halske potentiometer and a certified standard cell. The knife-edges are bolted to a small glass plate to ensure constancy of distance apart, and the bars, during the measurements, were immersed in a bath of paraffin oil, the temperature of which could be maintained at any desired point during the measurement. Measurements could be easily duplicated to within less than 0.05 microhm, and it is thought that the values given do not differ more than 0.2 microhm from their absolute value.

The thermoelectromotive force developed over the temperature gradient 0 deg. C. to 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C. was determined by the following method: Three bars of the same steel and of the same heat treatment were fastened together by means of small pure iron clamps so as to form a triple bar about 43 centimeters in length. One end of this triple bar was clamped to one end of a similar triple bar which in the case of freshly quenched or tempered bars was made up of three small bars of the same steel in the annealed condition. The thermoelectromotive potential of annealed bars was obtained by opposing to a triple bar of the annealed steels a triple bar made up of pure ingot iron. The compound bars were so shaped that the point of connection of the heat-treated and annealed triple bars was immersed in the oil bath also used for specific resistances. By means of small clamps machined out of carefully annealed ingot iron, pure iron wire leads were attached to the outer ends of the two triple bars. The upper temperature was that of the oil bath in which the connected inner ends of the two triple bars were immersed. The lower temperature of the gradient was obtained by supporting the outer ends of the triple bars in two large assay crucibles filled with crushed ice. A vertical slot 7 or 8 millimeters wide and 5 centimeters deep was sawed in each crucible, the bottom of the slot serving as a support for one end of the triple bar. A small hole was drilled in the bottom of the crucible to prevent accumulation of water and the crushed ice was prevented from falling out through the slot by a small piece of sheet copper, bent so as to hang from the top of the crucible on the inside, but not quite reaching to the bottom.

The ends of the pure leads not connected to the compound bars were attached by means of small connectors to the copper conductors leading to the galvanometer. The connectors joining the iron leads and copper conductors were placed in a small bottle of paraffin oil, the object of this being to ensure both connectors being at the same temperature. The galvanometer used is the same as that employed in measuring specific resistances and the deflections are converted into micro-volts by comparing with those obtained by connecting to a standardized resistance through which a known current was passed. Six micro-volts produced one millimeter deflection on the galvanometer scale, on which by means of a telescope and cross hair tenths of a millimeter can be estimated. Duplicate determinations could be kept inside of five or six micro-volts, and it is thought that the values obtained are not more than ten micro-volts from their true value.

The specific resistances of the pure iron and seven steels are shown in Table II, in which table the steels are arranged according to their carbon content. In this table the first column indicates the name of the steel; the second, the per cent of carbon; the third, the heat treatment; the succeeding five columns give the specific resistances at the different temperatures, while the last column gives the increase in specific resistance

from 25 deg. C. to 100 deg. C. The difference in the specific resistance of freshly quenched samples and the same steels after tempering at 105 deg. C., both being measured at 25 deg. C., clearly shows the instability of the solid solution in freshly quenched metal and why it was necessary to temper at 105 deg. C. if consistent results were to be obtained with temperature of measurement as high as 100 deg. C.

are given in Table III and are shown graphically in Fig. 1, in which also is shown the absolute resistivity of pure iron.

The results of the thermoelectromotive potential measurements are given in Table IV, in which the steels are arranged in the same order as in the preceding table and shown graphically in Fig. 2. In this table the thermoelectromotive potential of the freshly quenched

TABLE II

Steel	Per Cent Carbon	Heat Treatment	Resistivity Measured at 25° C.	40° C.	60° C.	80° C.	100° C.	Increase of Resistivity 25° C.-100° C.
INI	0.018	Annealed from 778° C.	10 64	11 43	12.49	13.67	14.91	4.27
		Quenched from 1002° C.	55.39					
SN3	0.104	Quenched and tempered at 105° C.	55.22	55.71	56.38	57.10	57 95	2.73
		Annealed from 985° C.	53.37	53.91	54.66	55.46	56.45	3.08
		Quenched from 900° C.	29.53					
M8	0.326	Quenched and tempered at 105° C.	28.60	29.33	30.42	31.64	32.84	4.24
		Annealed	25.29	26.02	27.17	28.41	29.72	4.43
		Quenched from 900° C.	30 39					
H12	0.61	Quenched and tempered at 105° C.	26 48	27.27	28.40	29.72	31.12	4.64
		Annealed from 720° C.	19.15	19.94	21.08	22.35	23.75	4.60
		Quenched from 902° C.	37.48					
C5	0.945	Quenched and tempered at 105° C.	26.15	27.07	28.40	29.79	31.25	5.10
		Annealed from 903° C.	16 96	17.63	18.78	20.07	21.48	4.52
		Quenched from 1002° C.	68.87					
SN1	1.11	Quenched and tempered at 105° C.	63.59	64.45	65.63	66.83	68.05	4.46
		Annealed from 950° C.	41.62	42.36	43.39	44.45	45.72	4.10
		Quenched from 1002° C.	68.68					
MN1	1.15	Quenched and tempered at 105° C.	68.54	69.73	71.55	73.43	75.32	6.78
		Annealed from 810° C.	54.31	55.19	56.70	58.42	60.31	6.00
		Quenched from 902° C.	47.44					
INC	1.18	Quenched and tempered at 105° C.	30.32	31.58	33.31	35.10	37.07	6.75
		Annealed from 905° C.	15.81	16.82	18.23	19.67	21.14	5.33

Since such a large proportion of the total resistivity is due to solutes in solution and since annealing produces precipitation of some of the solutes, particularly carbides, if we subtract from the resistivity of tempered steel the resistivity of the same metal in the annealed condition we would have that portion of the electrical resistivity which is due to those solutes which are in solution in the tempered, but not in solution in the annealed steel. These differences of resistivities

and that of the samples tempered at 105 deg. C. is the potential due to those solutes which are in solution in the quenched or tempered samples, but which are not in solution in the same steel in the annealed condition since in making these determinations the steel in the annealed condition is opposed to the same steel quenched or tempered, as the case may be. The thermoelectromotive potential of the annealed steels was the difference in the thermoelectromotive potential of the an-

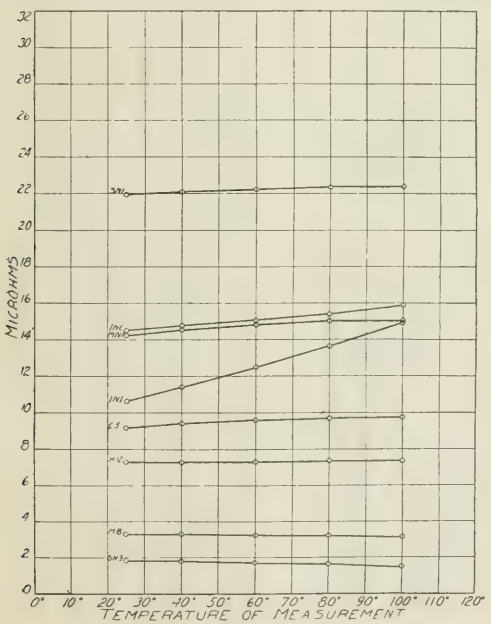

FIG. 1.

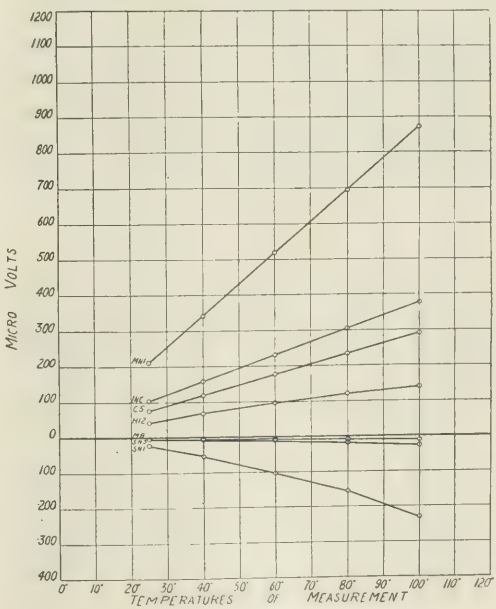

FIG. 2.

Table III

Steel	Per Cent Carbon	Difference of Restivity of Steel Tempered at 105° C. After Quenching and Same Steel Annealed Measured at 25° C.	40° C.	60° C.	80° C.	100° C.	Increase in Resistivity of Solutes 25° C.-100° C.
SN3	0.104	1.85	1.80	1.72	1.64	1.50	—0.35
M8	0.326	3.31	3.31	3.25	3.23	3.12	—0.19
H12	0.61	7.33	7.33	7.32	7.37	7.37	0.04
C5	0.945	9.19	9.44	9.62	9.72	9.77	0.58
SN1	1.11	21.97	22.09	22.24	22.38	22.33	0.36
MN1	1.15	14.23	14.54	14.85	15.01	15.01	0.78
INC	1.18	14.51	14.76	15.08	15.43	15.93	1.42

nealed steel and that of pure iron, since in making these determinations bars of the annealed steels were opposed to triple bars of ingot iron. The thermoelectromotive potential of quenched or tempered bars may be readily calculated by adding the thermoelectromotive potential obtained when these bars are opposed to the same steel annealed to that obtained when the annealed bars are opposed to ingot iron.

In Table V are given the thermoelectromotive potentials of three steels in both the annealed and tempered condition when opposed to pure iron. The reason for selecting these steels is that in the steel marked INC we have a high concentration of carbides only as the solutes, in SN3 there is a very high concentration of silicides with a small content of carbides, and in SN1 there is a rather high concentration of both carbides and silicides. The results given in Table V are shown graphically in Fig. 3.

An examination of the data given in Tables II and III and of the curves shown in Fig. 1, clearly reveals that the portion of the electrical resistivity due to the carbides or other solutes in solution does not follow the same law, as far as the influence of temperature of measurement goes, as does the electrical resistivity of pure iron, the solvent. The electrical resistivity due to carbides increases somewhat with the temperature of measurement, although the coefficient of this increase would not be more than about one-fourth that of pure iron, while the electrical resistivity due to silicides in solution has a small negative temperature coefficient. The temperature coefficient of the electrical resistivity due to tungsten or nickel in solution seems to be also slightly negative.

Viewed in the light of the solution theory in the full sense of the term, the influence of heat treatment on the resistivity of steels becomes quite clear. If in any solution it is those molecules of solutes in solution which are most reactive toward different forms of energy, then a piece of steel in the freshly hardened condition should have its maximum specific resistance since such a piece of freshly hardened metal would have the maximum proportion of its solutes in solution and consequently these solutes would transform a maximum amount of electrical resistivity. The electrical resistivity of steel is a function of the total molecular concentration of all solutes actually in solution.

Table IV

Steel	Per Cent Carbon	Heat Treatment	Opposed to	Thermo E. M. F. Measured at 25° C.	40° C.	60° C.	80° C.	100° C.	Increase in Th. E. M. F. of Solutes 25° C.-100° C.
SN3	0.104	Quenched from 1002° C.	SN3 annealed	0	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	SN3 annealed	—3	—6	—10	—16	—27	—24
		Annealed from 985° C.	Ingot iron	556	890	1334	1772	2206	1650
M8	0.326	Quenched from 900° C.	M8 annealed	—3	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	M8 annealed	—4	—5	—6	—8	—12	—8
		Annealed	Ingot iron	371	596	894	1186	1468	1097
H12	0.61	Quenched from 900° C.	H12 annealed	80	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	H12 annealed	44	68	96	120	138	94
		Annealed from 720° C.	Ingot iron	138	218	320	412	490	352
C5	0.945	Quenched from 902° C.	C5 annealed	192	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	C5 annealed	76	118	176	234	290	214
		Annealed from 903° C.	Ingot iron	128	204	292	374	452	324
SN1	1.11	Quenched from 1002° C.	SN1 annealed	—4	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	SN1 annealed	—22	—54	—102	—156	—232	—210
		Annealed from 950° C.	Ingot iron	362	578	862	1126	1382	1020
MN1	1.15	Quenched from 1002° C.	MN1 annealed	216	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	MN1 annealed	212	340	518	694	872	660
		Annealed from 810° C.	Ingot iron	334	524	764	990	1210	876
INC	1.18	Quenched from 902° C.	INC annealed	262	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	INC annealed	102	158	2 0	302	376	278
		Annealed from 905° C.	Ingot iron	90	138	200	258	302	212

Table V

Steel	Per Cent Carbon	Heat Treatment	Opposed to	Thermo E. M. F. Measured 25° C.	40° C.	60° C.	80° C.	100° C.
SN3	0.104	Annealed from 985° C.	Ingot iron	556	890	1334	1772	2206
		Quenched and tempered at 105° C.	Ingot iron	553	884	1324	1756	2179
SN1	1.11	Annealed from 950° C.	Ingot iron	362	578	862	1126	1382
		Quenched and tempered at 105° C.	Ingot iron	340	524	760	970	1150
INC	1.18	Annealed from 905° C.	Ingot iron	90	138	200	258	302
		Quenched and tempered at 105° C.	Ingot iron	192	296	430	560	678

A study of the data in Tables IV and V and of the curves shown in Figs. 2 and 3 reveals at once that the thermoelectromotive potential due to solutes in solution is not a function of the molecular concentration of the solutes actually in solution, as is the electrical resistivity. From the data in Table IV and curves in Fig. 2 it will be noted from steels C5, INC and MN1 that, within limits of experimental error and over the temperature range 0 deg. C. to 100 deg. C., the thermoelectromotive potential due to a single solute in solution is a linear function of the temperature. In case of two or more solutes in solution at the same time this would not hold, as is shown in case of steels SN1, SN3, M8 and H12. This thermoelectromotive potential of a single solute is dependent upon the composition of the solute and its concentration. A hypothesis that the thermoelectromotive potential of a solute in metallic solution is analogous to the solution tension of an electrolyte in an aqueous solution, would offer a reasonable explanation for the thermoelectromotive potential results found in the present investigation. This is best shown from the data in Table V and curves in Fig. 3.

If an electrolytic cell be set up with a single electrolyte A, the electromotive force of such cell will depend upon the solution tension of the electrolyte and the concentration. If a second cell with a single electrolyte B, whose solution tension is higher than that of A, be set up, it will also have an electromotive force dependent upon the solution tension and concentration of the electrolyte B. If a third cell be set up with a mixture of the electrolytes A and B, it will have an electromotive force intermediate between that of A and B, always being higher than that which would be found with A alone, but lower than if B were the only electrolyte. Electrical conductance in aqueous solutions is dependent upon the total ionic concentration, but is not dependent upon the solution tension of the solutes, this latter being wholly dependent upon chemical composition.

In steel INC we have a single solute, carbides, the thermoelectromotive potential of which is dependent upon the concentration of the carbides brought into solution by hardening. The thermoelectromotive potential of the hardened metal is higher than that of the same steel in the annealed condition. In case of the steel SN3 we have a very high concentration of silicides which seems to be almost as soluble in *alpha* iron as in iron in the *gamma* form; but in the annealed metal the carbides corresponding to 0.104 per cent carbon would be almost completely precipitated. On hardening such a metal the carbides would go into solution and we would have in solution a high concentration of silicides together with a low concentration of carbides and, in consequence, a thermoelectromotive potential slightly lower than that which is given by the annealed steel in which the silicides alone were in solution. Owing, however, to a slight increase in molecular concentration of solutes in the hardened metal, the electrical resistivity is correspondingly increased. This effect of two solutes in solution is shown still more strikingly in the case of SN1 in which we have 1.20 per cent and 1.11 per cent carbon. In the annealed condition the greater part of the carbides would be precipitated and the thermoelectromotive potential would be due to the silicides alone. On hardening, however, the carbides would pass into solution, and since the thermoelectromotive potential of carbides is much less than that of silicides, the thermoelectromotive potential of the hardened or tempered metal would be lower than that of the same metal annealed, although the specific resistance would be very much increased.

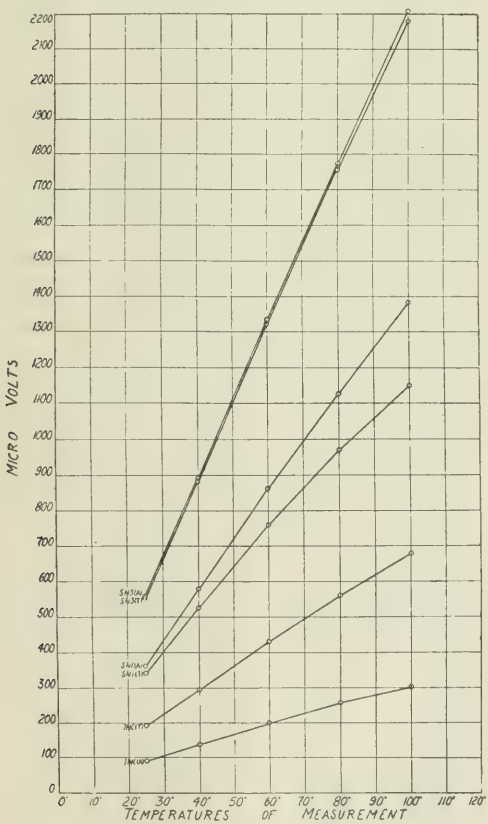

FIG. 3.

SUMMARY OF CONCLUSIONS

1. The total electrical resistivity of steel is made up of two components, that portion due to the solvent iron, and that portion due to solutes in solution, the two portions not following the same laws so far as the temperature of measurement is concerned.

2. The temperature coefficient of the electrical resistivity due to carbides in solution is positive, but only about one-fourth as great as that of pure iron.

3. The temperature coefficient of the electrical resistivity due to silicides, as well as that portion due to tungsten and nickel in solution, is small but negative.

4. The thermoelectromotive potential of a single solute in solution is dependent upon the chemical composition and concentration and is a linear function of the temperature.

5. When two or more solutes are in solution at the same time the thermoelectromotive potential due to these solutes is not a linear function of the temperature and not dependent upon the total molecular concentration.

6. To account for the observed phenomena of thermoelectromotive potential, the hypothesis is advanced that the thermoelectromotive potential of solutes in metallic solution is analogous to the solution tension of electrolytes in aqueous solution.

University of Michigan.

Warning Against Hoarding of Coal

The United States Fuel Administration announces to industrial consumers and manufacturing establishments that if any shortage of domestic coal develops it is due to the individual hoarding of coal and may result in its redistribution by the apportionment and distribution division of the United States Fuel Administration. The production of anthracite coal for the present year will be 10 per cent in excess of the production for 1916. The demand is also greater. Figures are not available as to the increase of production in bituminous.

The Fuel Administration has information and is conducting a general inquiry in the direction of the storing of coal by industrial consumers and various manufacturing establishments.

A Permanent American Dyestuff Industry*

By H. Gardner McKerrow†

There have been many romantic chapters in the industrial history of the United States, apparently insuperable difficulties overcome and obstacles surmounted, but it is doubtful if history will accord a greater measure of appreciation to any than it will to the way in which, in the brief period of two years, American manufacturers have met and substantially conquered the dyestuff situation. Prior to the breaking out of the European war our dependency on foreign countries for the needs of our color using industries was practically absolute. Approximately 90 per cent of the artificial colors used at that time were imported, and even as regards the 10 per cent which was manufactured in this country, the American dyestuff maker was largely dependent on foreign sources of supply for his intermediates.

At that time there were only five concerns engaged in the making of coal tar colors, and these were continuing their operations either at an actual loss or at least without profit, and in the somewhat forlorn hope that there would be some development, either in the form of more considerate legislation, or extended markets, which would justify their courage and persistence.

The production of crudes and intermediates was in an even less encouraging condition, and with a long continued minimum of demand from the Government for those intermediates which would be employed in the making of munitions, during "the piping times of peace," there was little inducement for capital to seek avenues of employment in the exploitation of coal tar products.

In addition to the artificial dyestuffs used prior to July, 1914, possibly 10 per cent of the color requirements of this country was supplied by the natural dyestuffs or dyewoods, such as logwood, fustic, cutch, gambier, quercitron, sumac and the various redwoods from which such dyes as hypernic are made. Of these, two only were native products of this country, quercitron, which is the extract of black oak bark, and sumac, the product of the leaves of the well known native shrub of that name.

The exigencies of the situation since the war commenced have sent investigators far afield to discover new sources of color, and among an immense mass of more or less useful data and experimentation one native product stands out pre-eminently and takes its place as a worthy companion of the two older native coloring mediums—osage orange, to which I shall have occasion to refer with greater detail later.

Of the natural dyewoods which were drawn from foreign countries logwood from Jamaica, Mexico and Haiti; fustic from Cuba and Mexico; cutch and gambier from India and Burma; Brazil wood from Brazil; Lima wood from Peru, it may be said that the same causes which called them into exceptional demand also made them more difficult to obtain, by reason of the shortage of shipping facilities, the imposition of embargoes, and other conditions made necessary by war developments.

At times during the past two years it has been impossible to secure regular and sufficient supplies of these materials, and this added to the cutting off of the supply of artificial dyestuffs, and intermediates from Germany precipitated an incipient panic among our mills which will be only too well remembered by members of this association, and during which prophecies of the shutting down of industrial plants, and the approaching inability of our factories to supply anything but white goods were generally made.

Since that time, in addition to the original five companies engaged in making artificial dystuffs, upwards of 90 enterprises, large and small, some making only one special color, others making more or less extended lines, have come into existence, and over 100 concerns are now engaged in the manufacture of the crudes and intermediates from which the colors must be made.

Mr. Stone has told us of the work that has been accomplished by the older and more experienced makers, as well as by some of the newcomers in the industry; of the colors that have been added to the original list of American made colors; of the industries that have been rescued from imminent stultification, and have been restored to a position where they can still supply the demands of their customers, and deliver the shades and colors to which they have become accustomed.

Granted that we now have, not the nucleus only, but a well grown actuality, even if not yet approaching maturity, in the matter of a dyestuff industry, it is not too soon to consider the ways and means to make that industry a permanent asset in the industrial life of this country, and not a merely ephemeral effort, meeting with more or less efficiency, an exceptional and temporary need.

Of the several requisities to this end which I propose to consider at this time, I place first and foremost, as far transcending any other condition, the absolute and indispensable necessity of earnest and patriotic support on the part of the manufacturers themselves. By this I do not mean a willingness to support the new industry by using American made colors simply during the time when no others are available, with a mental reservation that you will revert to the use of German colors just as soon as they again become available, but by a broad-minded realization that the interests of the new industry are your interests, and that its permanent intrenchment in the industrial family of our country means an added success to your particular industry, and an asset on your particular balance sheet which you cannot afford to disregard. It will require patience on the part of the color user; it is not to be expected that the dyestuff makers can produce in all their characteristics and amplitude, in a period of less than two years a range of shades which took Germany 30 years to develop. The progress already made has been marvellous, and color for color, and type for type, it can be fairly said that the American dyes, made from pure intermediates and following the chemical formulæ which foreign makers have made standard, are just as brilliant, and just as fast as the foreign dyes.

Shortly after it became evident that the United States seriously proposed to emancipate her industries, as far as colors were concerned, once and for all from German domination, an insidious propaganda was carefully and industriously circulated throughout this country largely through the medium of certain clothing associations, acting consciously or unconsciously as circulating channels, that American dyes were not fast, and could not, therefore, be guaranteed. To this day it is possible for

*An address delivered at the Springfield Meeting of the National Association of Cotton Manufacturers.

†Marden, Orth & Hastings Corp., New York.

the buying public to purchase goods over the counters of our retail stores, and he assured that "as the dyes are American, and not German" the goods cannot be, and are not guaranteed. Innocently these retail stores are lending themselves to a characteristically German attempt to poison the mind of the average American man or woman, and instill into them belief that no dyes are fast except German dyes.

Were these people to realize that their action is essentially unpatriotic and un-American, and that it is deliberately playing into the hands of our enemies, it is not to be supposed for a moment that they would continue the practice. As a matter of fact, there never was a pound of even German dyes sold in this country without the stipulation on the package that it was sold "without guarantee," nor was there ever a shade offered on a color card showing German colors without the same reservation.

It is doubtless quite true that in the first year or so after the war commenced a vast amount of goods were placed on the market, both piece goods, yarns and hosiery, on which the colors were anything but fast, and to the extent to which this happened, the public was confirmed in the doctrine with which it was being inoculated. This was before, however, an adequate supply of American colors was available, and these goods were dyed in the panic stricken time when even the very floors of mill store rooms were being scraped for color.

As was very pertinently pointed out in a recent issue of the *Color Trade Journal,* the most extraordinary blends and compounds of tag ends of German colors were used in order to get the shades required, and without any reference to subsequent results.

In the same journal Mr. Edward S. Chapin has also very justifiably pointed out that some shades, obtained during this period by the use of natural dyestuffs, were secured under an entire ignorance of the proper use of mordants, and by methods of dyeing and combinations of treatments which could only give notoriously unfast results.

The new industry is suffering from these conditions to-day, and under the best of circumstances, it will be many a long month before the average housewife will be convinced of the serviceableness of American dyes, and will be willing to exhibit a preference for instead of a prejudice against American goods dyed with American dyes.

The patriotic manufacturer, willing even to make sacrifices in order to do his part in insuring this industry against extinction, will realize that it is his privilege, and his interest, to support the makers of dyes in this country by encouraging their efforts, by patience with their delays, and by condonation of their mistakes until they shall have learned by experience those finer and more intimate secrets of manufacturing methods which Germany only learned after two generations of patient research.

To the everlasting credit of some of our large manufacturers it must be said, and frankly and gratefully said, that they have accorded this co-operation and support to the new industry. They have purchased liberally of the domestic colors, and if the quality of shades obtained have not been just what they wanted in the first instance they have been willing to try again and yet again.

This need of appreciation, however, cannot be accorded to a very considerable proportion of the manufacturers of this country. This proportion has not shown an earnest and patriotic spirit in the encouragement of the new industry and has evinced a somewhat selfish disposition in its attitude towards the efforts that have been so freely and fully undertaken. They have exhibited an impatience with those who were shouldering the burden of creating this new industry and have not realized that the complications of the work were such that it has been impossible to expect immediate results which would be fully on a par with the results achieved by Germany after years of effort.

There has been a disposition on the part of some manufacturers to demand colors which would correspond identically with certain marks and brands which were in common use before the war, and they have not shown a willingness to co-operate with the domestic color manufacturers in arriving at a basis of standardization which would enable a fair comparison to be made between domestic and foreign colors.

Let me give an instance of what I mean. I recently received a letter from a certain manufacturer inquiring for some colors of which he was badly in need, and I will quote a single sentence from this letter: "These must be German colors; I do not care to take any chances with American colors." Now, I do not doubt but that gentleman wears an American flag in his button hole, and possibly his boy is in one of the National Army camps and perhaps he, himself, is a member of the home guard in his own town, but, somehow, I do not envy him his particular brand of patriotism.

I have referred to the question of a standardization. This is the second principal requisite to insure the permanence of the dyestuff industry, and is a question in which the color-using manufacturers are equally interested with the color makers. It is absolutely essential that steps should be taken at once to standardize American colors so that a manufacturer may know the relative values of offerings and just what he is buying in point of color value.

At present each manufacturer, if he has any standard at all, has his own, and the strength of one man's product bears no relation to another's and it is almost impossible to gage the value of a color by the price. If America is to make a permanent thing of its dyestuff industry it must establish its own standards; not the standards of one or more dominating interests working alone and without relation to the industry as a whole, but working co-ordinately with all reliable dyestuff makers.

How this can be done is receiving careful consideration at the present time from the various interests concerned. My own idea is that this can be most fairly and effectively managed by the dyestuff manufacturers themselves. I would suggest, as I have done before, the calling of a conference of the dyestuff manufacturers at which the fundamental principles of this question could be discussed and settled, and at which a permanent board of expert color chemists and manufacturers could be appointed that could act as a bureau of standards, and could authoritatively standardize new colors as they were produced.

I doubt if any permanent satisfaction could be obtained from a Government Bureau of Standards, such as has been proposed. We are tending too much towards a paternalistic government, and are calling for

bureaus for this and bureaus for that, the work of which is seldom as thorough and practical as when it is undertaken as a business proposition by the parties interested. I would recommend, as a means of establishing a ratio between standards agreed upon and the price at which goods should be sold, that the selling price should be per unit of color value. Then, no matter whether the dye was sold as a concentrated powder, or as a paste containing 75 per cent of moisture, no matter to what extent the color might be salted or otherwise adulterated, its relative value as against the standard would be fixed. It would be equally fair and effective for one manufacturer as for another.

A permanent board such as I have outlined could properly fulfil other functions besides that of standardizing colors. It could be the means of defending the standards so established. It could serve as a board of arbitration in all matters of dispute involving the question of quality or correspondence of deliveries to sample. Prompt and expert decisions on such matters would not only save time and endless expense in litigation—which under the legal rules of evidence no layman can hope to understand, and which seem designed rather to conceal facts than to bring them out—but would relieve the congestion of court dockets, which are in all industrial centers choked with cases of dispute as to quality of dyes delivered.

I have seen it stated that there are over 3000 such cases in the New York courts alone; all the result of the last two years' feverish conditions in the dyestuffs market, and all awaiting their turn on a docket which has swamped clerks and courts alike for decision.

This involves also the integrity of contracts, where questions of quality have been raised. A disconcerting disposition has been evidenced on the part of many manufacturers to cancel contracts which were entered into in perfectly good faith by the dyestuff manufacturers whenever the market shows any tendency toward declining values.

In other words, a contract is in many quarters only regarded as a contract when it operates to the advantage of the purchaser. This is distinctly unfair and is an evil which is notoriously prevalent in many other lines and is one which is distinct menace to American business.

It is quite evident that when a dyestuff manufacturer undertakes to supply a given quantity of his products to a manufacturer in, for instance, monthly deliveries for a period of time, he commits himself to certain responsibilities in the way of raw materials from which he cannot relieve himself at will and therefore a cancellation on the part of his customer may cause him very serious loss, to say nothing of the loss of profitable business on which he has counted. In 1915 and 1916, when it was a case of first come first served, contracts for dyes to be taken over a term of years at prices far above normal were eagerly accepted, and conditions were agreed to which justified the description of the situation in those two hectic years as "a seller's market."

So far, in the continued absence of strongly competitive conditions, these contracts have been lived up to fairly well, but as new firms come into the market, as methods of manufacture are improved, and prices are reduced, there is a growing tendency on the part of the buyers to demand protection against a falling market. When the war ends and conditions of the tides of commerce again flow unobstructedly through the ordinary channels of supply and demand, human nature would have lost one of its most universal characteristics if there were not attempts to avoid the pressure of contracts which had become burdens.

If, when these conditions confront us, we had an impartial expert board to which such questions of contract could be referred by the mutual consent of the disputing parties, when such disputes involved the question of quality as against standard—and this is the ground on which 90 per cent of contract repudiations will rest—the trade would know that decisions could be reached intelligently and promptly, and without the interminable delay of the law.

The third requisite for the permanent establishment of the industry is that the Government should accord an adequate degree of protection, and efficient well-administered laws against the "dumping" of foreign dyestuffs on this market at prices which are below the market prices in the country of origin.

When the war commenced the duty against dyestuffs was 30 per cent ad valorem, and against intermediates 15 per cent ad valorem. While this was a very considerable degree of protection it is evident that it bore most heavily against the higher priced and less used dyestuffs, while the ordinary colors, such as the standard blacks, blues and browns, retailed before the war at from 15 cents to 25 cents per pound, hardly felt the benefit of such an ad valorem impost. These are the colors which are in by far the largest bulk demand, and it was at once evident that when the time came to meet the relentless competition of the German manufacturers struggling to recover some of the lost ground and forfeited markets which insatiate ambition has inflicted upon them, it would be perfectly feasible for them to "dump" these cheaper colors on this market at prices which would defy competition, while making up their margin of profit on the higher priced colors which American dyestuff makers have not commenced to make, and possibly will not make for many years to come.

It has been perfectly natural for our manufacturers of colors to follow the line of least resistance, and to devote their initial efforts to those colors which are in the largest demand, and which are the most easily made, but in so doing they have naturally exposed the new-born industry to attack on its most vulnerable side, unless the Government recognizes the necessity of sufficiently protecting its interests.

To some extent this has been done in the legislation effected last year. In addition to the 30 per cent and 15 per cent ad valorem duty, a specific rate of 5 cents per pound on finished dyestuffs, and 2½ cents per pound on intermediates was added, and a clause intended to prevent "dumping" was enacted into law, all of which was a long step in the right direction, and has given distinct encouragement to capital considering investment in dyestuff making developments. But it is not enough to place the industry beyond risk of dangerous competition when normal conditions are restored. The bill introduced by Congressman Hill, which provided for a specific rate of 7½ cents per pound on finished dyestuffs, and 5 cents per pound on intermediates, in addition to the existing 30 per cent and 15 per cent ad valorem rates, came much more nearly meeting democratic administration.

With their commerce at a standstill, their factories denuded of skilled help, and their financial systems disorganized, those European countries which have devoted themselves in happier times to the development of the science of dyestuff making will leave no stone unturned to get back what they regard as their own, and in commerce, as it has been in matters military, anything is justifiable where a struggle for existence is involved.

It is therefore evident that those who realize that the dyestuffs industry, as a permanent unit of the industrial organization of this country, is an indispensable necessity, should use every effort, individual and corporate, to obtain for it Congressional influence which will give it a fair chance to exist through the days of its incipient growth to a self-supporting and independent maturity.

A Method for the Commercial Analysis of Ferro-Silicon*

By Russell E. Lowe†

This analytical procedure is the result of an extended series of experiments, carried on with the purpose of evolving a rapid and accurate method for the analysis of ferro-silicon without the aid of the powerfully oxidizing fluxes at present used. By "commercial analysis" is meant the quantitative determination of sulphur, phosphorus, manganese, iron, aluminium and silicon, since these elements are the ones generally specified in contracts for the 50 per cent alloy.

The older procedures for the analysis of ferro-silicon require a flux consisting of 20 grams of sodium carbonate and 4 grams of potassium nitrate to break down a 1-gram sample of the alloy. A fusion of this character is decidedly destructive to platinum, and in addition requires almost constant supervision because of its tendency to creep over the side of the crucible. Another, and a great fault of the fusion method is that it is slow. Because of the minute quantities of impurities present in the alloy, a gram sample at least must be used. This means the tedious handling of a large volume of silica, and involves a second fusion since it is impossible to wash silica absolutely free from the heavy metals.

The following method of procedure has been tried on several samples of ferro-silicon that were previously analyzed by an outside laboratory of recognized standing, and in practically all cases the agreement was found to be within the limits of experimental error. The method is recommended as being simple, accurate, rapid, and saving of platinum.

DETERMINATION OF SULPHUR AND PHOSPHORUS

Mix sample thoroughly and powder in a diamond mortar until it passes through a 100-mesh screen. Weigh about 1 g. of the powdered sample into a 100 c.c. platinum dish, add 25 c.c. of concentrated nitric acid, cover with a watch glass and place on a boiling-water bath. When the contents of the dish have reached the temperature of the bath add a few drops of hydrofluoric acid. As soon as the resulting violent reaction has ceased add a second portion of the acid. Continue this procedure until only a slight residue is visible on the bottom of the dish, then add about 5 c.c. more of hydrofluoric acid. Remove the watch glass, carefully washing any matter adhering to it into the platinum dish with a stream of hot water, and evaporate the solution to dryness. Add 10 c.c. of concentrated nitric acid to the contents of the dish and repeat evaporation on water bath. Dissolve residue in dish with 50 c.c. of a 5 per cent solution of nitric acid, heating to hasten the process.

Add to the dish a concentrated solution of sodium carbonate in small portions and with constant stirring until it is present in slight excess, then transfer the contents to a glass beaker and dilute with hot water to about 200 c.c. Heat contents of beaker to boiling and allow to settle. Filter solution through a 12.5 cm. filter, washing the precipitate five times with hot water.

Sulphur.—The filtrate contains the sulphur, and to it is added an aqueous solution of calcium chloride until the precipitation of calcium fluoride and calcium carbonate is complete. Boil the solution for a few minutes, allow the precipitate to settle, filter through a 12.5 cm. filter paper. Wash the precipitate five times with hot water.

Acidify filtrate from the calcium chloride precipitation with hydrochloric acid. Heat the solution to boiling and add 25 c.c. of boiling 6 N barium chloride. Allow solution to stand in a warm place for one hour, then filter through a 9-cm. No. 42 Whatman filter, or its equivalent. Wash filter with hot water until it is free from chlorides.

Ignite this filter in a weighed platinum crucible, cool in desiccator and weigh the sulphur as barium sulphate. Calculate to sulphur. As in all sulphur determinations it is advisable to run a blank carrying out the procedure as given, omitting of course the sample, otherwise results are apt to be too high.

Phosphorus.—The sodium carbonate precipitate contains the phosphorus, as iron *phosphate.* This precipitate is dissolved from the filter with hot nitric acid, sp. g. 1.13 (approximately 1 volume of concentrated nitric acid to 3 of water). Fifty c.c. of the acid will be found ample if it is poured through the filter several times. When the precipitate is completely dissolved the filter is washed, first with a 1 per cent solution of nitric acid, then with hot water until it is free from iron.

The solution is now heated to boiling, with the addition of a few drops of a concentrated solution of potassium permanganate, and kept at this temperature for about five minutes. Add a solution of ferrous sulphate in water, acidified with sulphuric acid, until any precipitate of manganese dioxide dissolves and the solution becomes quite clear.

Remove solution from the source of heat and add 50 c.c. of ammonium molybdate solution. Allow to stand for 30 minutes, filter through a 9-cm. filter paper, then wash first with 1 per cent nitric acid solution, second with hot water until the yellow precipitate is free from iron.

After the method of J. O. Handy,[1] transfer the filter paper and yellow precipitate to a glass beaker, add a definite volume of sodium hydroxide solution that has been standardized against a steel of known phosphorus content, and titrate for the excess of alkali with a standardized solution of nitric acid. Calculate to phosphorus.

*A paper presented at the Thirty-second General Meeting of the American Electrochemical Society, in Pittsburgh, Oct. 3-6, 1917.

†Chemist, The FitzGerald Laboratories, Inc., Niagara Falls, N. Y.

[1]Blair, Chemical Analysis of Iron, 7th ed., p. 104.

DETERMINATION OF MANGANESE, IRON, AND ALUMINIUM

Weigh about one gram of the finely powdered sample into a platinum dish and proceed with the decomposition of the alloy in a manner identical with that given in the sulphur-phosphorus procedure, up to and including the first evaporation to dryness.

Cover residue in the dish with 25 c.c. of a 1:5 solution of sulphuric acid. Evaporate solution almost to dryness. Cool. Add 25 c.c. of distilled water, raise contents of the dish to the boiling point, then transfer to a glass beaker. Add 100 c.c. of water, a few drops of concentrated hydrochloric acid and boil until solution is complete. Determine manganese, iron and aluminium in this solution in the regular manner, as given in Blair's "Analysis of Iron and Steel," or any standard work on qualitative analysis.

DETERMINATION OF SILICON

Silicon is calculated by summing up the percentages of the elements determined and subtracting from 100.

For an extremely rapid but approximate determination of silicon, accurate within 0.5 per cent, weigh 0.25 g. of the sample into a weighed platinum dish. Decompose with mixed acids as before. Evaporate solution to dryness. Ignite dish at red heat, cool in desiccator and weigh. Assume residue to be entirely composed of iron oxide. Calculate to iron and subtract this value from the weight of the sample, calling the difference silicon.

Notes on the Analysis

1. Nitric acid must be added first to prevent the volatilization of iron, sulphur, phosphorus, etc., as fluorides.

2. By keeping the solution hot it is possible to maintain a much more even rate of decomposition. When hydrofluoric acid is added to a cold solution the reaction is very apt to start with such violence as to eject the contents of the dish.

3. The treatment with sodium carbonate prior to transferring the solution from platinum to glass is necessary because of the traces of free hydrofluoric acid invariably present in the acid solution. For the determination of sulphur and phosphorus it is obviously impossible to make use of a sulphuric acid evaporation to remove the last traces of fluorine. Likewise, the contents of the dish cannot be evaporated to dryness and baked owing not only to the danger of volatilizing phosphorus, but also to the difficulty of getting the ignited oxides back into solution.

By the addition of sodium carbonate, the traces of fluorine remaining are converted to the fluoride and this is later removed by precipitation with calcium chloride in the sulphur determination. Before this method was adopted the etching of beakers and cover glasses was quite noticeable, while the presence of gelatinous silica made filtrations most difficult.

4. It is to be noted that in no case is there an evaporation of a ferric chloride solution in contact with platinum. This eliminates another source of loss of that expensive metal.

THE VOLATILIZATION OF PHOSPHORUS FROM FERROSILICON

In the course of the experiments for evolving the rapid method for the commercial analysis of ferrosilicon just described, the analytical procedures as worked out were tested on several samples of ferrosilicon that had been previously analyzed by the Pittsburgh Testing Laboratories by the regular method of porcedure.

The new method gave excellent checks in all but the phosphorus determinations, and here, invariably, percentages were obtained that were approximately half of that quoted, as the following data show:

	Per Cent of Phosphorus	
No. of Sample	P. T. L.	Rapid Method
410	0.022	0.0103
411	0.044	0.022

Feeling quite certain that the fault did not lie in the method but in the sample itself, the author repeated his work, this time using an oxidizing flux of carbonate and nitrate to break down the alloy. The results thus obtained also proved to be about half the reported values for phosphorus.

Sample No. 411 was then returned to the Pittsburgh Testing Laboratories for a new determination of phosphorus. While waiting for their report, an investigation of the laboratory files showed that the first analysis had been made in February, 1908, almost ten years previously.

In due time the Pittsburgh Testing Laboratories reported on the phosphorus content of the sample, their value being 0.020 per cent, a very satisfactory check upon the value, 0.022 per cent, by the rapid method.

From the above it seems reasonable to conclude that the volatilization of phosphorus from ferrosilicon is considerable, even when the alloy is kept in a dry place enclosed in screw-topped glass jars.

Coal Gas as a Gasoline Substitute.—The question of driving motor vehicles with coal gas as a substitute for gasoline continues to attract attention throughout the United Kingdom according to Commerce Reports. The press is devoting much space to the discussion of its advantages and disadvantages. The consensus of opinion appears to be that it is a practical proposition and should be adopted as widely as possible, at least for the present, in order to conserve the gasoline supply. The British Commercial Gas Association has been carefully investigating the subject, and in its report declares that coal gas in the present emergency may be advantageously used as a gasoline substitute by providing a large flexible holder in which the gas is stored approximately under atmospheric pressure.

There are no difficulties in adapting the ordinary engine to run with this fuel, as it may be employed without any structural alterations. Another important point is that no alteration in the carbureter is required. The gas bag is merely placed on the top of the car or van, and has one outlet and one inlet. The gas is carried to the carbureter and thence to the engine. The latter may be switched immediately from gasoline to gas or vice versa.

The experiments of the British Commercial Gas Association led to the conclusion that the equivalent of 1 gallon of gasoline is about 300 cubic feet of gas, but other experiments have given only 250 cubic feet or less, depending on the quality of the gas, which varies from one town to another. In practice it seems that coal gas will show appreciable economy compared with gasoline, as at normal prices gas worth 16 cents would do the work of a gallon of gasoline.

Causticizing Soda Liquors*

By Martin L. Griffin, Wallace H. Howell, Jr., and George K. Spence†

During the last few years chemical industry has been greatly stimulated by the extraordinary course of events. The cutting off of the supply of many imports from abroad and the demands made by the war have done much to bring this condition about. The builders of chemical appliances have made a distinct contribution by the enterprise they have shown. Very often they have been the leaders in improving and developing processes by making a study of them. The getting together of both builders and users annually at the National Exposition of Chemical Industries in New York will, I am sure, lead to increasing interest as time goes on.

INDICATIONS OF PROGRESS

As an illustration of this progress let me mention one subject of great general importance in chemical processing—the separation of solids from liquids. There are two fundamental ways of viewing this subject: First, by a counter current movement of the elements; Second, by straining or filtering out the solids.

The character and relative value of these elements will influence the choice to a great extent. Minor and incidental considerations must also be reckoned with. The making of caustic soda from the carbonate falls within the scope of this subject, and several new appliances and manipulations have been advanced and adopted for this work. Not until recently have any improvements been made in the manner of preparing the liquors for cooking wood by the soda process.

Therefore it seems timely and fitting for the Committee on Soda Pulp to present this subject to the Association for a wider knowledge and better appreciation of one of these newer developments in chemical industry applicable to the manufacture of pulp by the soda process.

Under the title

A Discussion of Different Processes for Causticizing Sodium Carbonate Liquors and the Separation of the Sludge

We will take up the following systems:

First.—Intermittent precipitation, sedimentation and decantation;

Second. — Continuous precipitation, sedimentation, washing and separation of the precipitate from the solution;

Third.—Intermittent or continuous precipitation, filter-pressing and washing for the separation of solids and liquids;

Fourth. — Intermittent or continuous precipitation, with continuous filtering and washing for the separation of solids and liquids.

THE OLD SYSTEM

Under the first heading is comprised the old process of adding the lime to the solution of soda ash in a tank constructed for this purpose and thereafter settling out the precipitated calcium carbonate and drawing off the clear liquor. The process of washing, settling and decantation is then repeated until the sludge is as free from alkali as conditions will permit.

The actual chemical processes must of necessity be the same in substance, whatever the subsequent mode of procedure may be. In soda pulp mills where the black ash must be leached out, the lime is added to the liquor in dry form; where caustic soda is made for market from finished soda ash, the process is reversed, and dry soda ash is added to milk of lime. In any case the lime must be brought into contact with the soda ash in solution and boiled to make the process effective. It is from this stage onward that improvements have been made which this committee is about to take up. This first and old process may be set forth in a general way as follows:

1. The causticizer—where the solution of alkali and lime are mixed and boiled. This may be a vertical, open, round tank, with a basket suspended for the lime, and an agitator; or it may be a horizontal, cylindrical, closed tank, with manholes, lime baskets, agitator and pipe connections. With this arrangement the boiling may be done with low pressure and the causticizing process made more effective.

It is very important that adequate plans be made for a careful measurement of the strength and volume of the alkali liquor used for each charge, so that the quantity of lime may be accurately adjusted.

2. A series of tanks follow for the subsequent settling, drawing off the liquor, boiling up and washing of the sludge. These tanks and causticizer should be of the same capacity and furnished with agitator and all necessary pipe connections. The process is one of quiescent settling of the precipitate, decanting the clear liquor, washing the sludge by a process of dilution, which practically and theoretically is never complete. The lower the concentration of the liquor to be causticized, the higher will be the causticizing efficiency. It is therefore desirable to make up the liquors of approximately the strength required for cooking the wood. The weak wash liquors must of necessity be disposed of in any system, by washing up strong sludges or used in leaching out the black ash.

Such a system requires a large number of tanks, piping, valves, floor space, buildings, labor, steam, etc.

THE DORR SYSTEM

Under the second heading, the causticizing process is best set forth by the system of the Dorr Company. It has been made continuous by the adoption of continuous agitation and continuous counter-current decantation. By the adoption of this company's equipment all operations become continuous, the soda ash, or soda liquor, and lime in proper proportions are mechanically fed to the first of a series of three reaction agitators which are fitted with steam coils. If the caustic liquors are to be made from soda ash, the wash liquors from the second thickener will gravitate to the first solution reaction agitator to furnish the required fluid volume. In pulp mills, however, this wash liquor must necessarily be used for leaching out the strong tanks of black ash. Three agitating tanks are provided, placed in series, so as to insure a continuous boiling for at least one hour to make the chemical reaction effective.

The pulp or precipitate and liquor flow continuously

*Report of the Soda Pulp Committee read at the joint convention of the Technical Association of the Pulp and Paper Industry, and the Technical Section of the Canadian Pulp and Paper Association at Holyoke, Mass., September 27, 1917.

†Respectively, chairman and associates of the Soda Pulp Committee.

through this series into the first thickener, the overflow from which is the strong liquor.

The underflow from each thickener is controlled by a diaphragm pump which delivers it at such a height that, joined by wash liquor or water, it gravitates to the next thickener in the series. The underflow from the last thickener either runs to waste or to a filter for final dewatering and reburning, if desired. It is claimed that by the use of thickeners a smaller total settling area is required than in intermittent work, since the tanks are working continuously and no time is lost in decanting, discharging and refilling.

The Dorr agitator and thickener are the particular devices placed in the tanks to obtain the efficient results sought, and do not include the tanks, properly speaking. The "agitator" can be operated in any flat-bottom tank, and consists of a central vertical cylinder carried by a shaft supported from the top of the tank and equipped with two arms carrying plows, which travel around the bottom of the tank and draw the pulp to the center. This is raised through the cylinder by means of air and distributed evenly over surface of the tank by suitable revolving launders or troughs. A continuous inflow and outflow is provided.

The "thickener" consists of a slow-moving mechanism placed in a suitable tank, by means of which the operation of settling may be made continuous through the removal of the settled material to a point of discharge. It consists of a central vertical shaft with radial arms equipped with ploughs, to bring the thickened material to a discharge opening at the center, by the slow rotation of the mechanism, where it may be discharged as desired. There is a peripheral launder which collects the clear liquid overflowing at the top of the tank. This whole process is designed for continuous work.

The Kingsport Pulp & Paper Company's new plant at Kingsport, Tenn., is equipped with this system.

It is well to note, in passing, that the Dorr devices have been worked out principally for the concentration of slimes and fine concentrates in the mining industry, in which the carrying fluid is water and has no value. In the manufacture of caustic soda, however, the valuable product is the liquid, while the pulp is a waste by-product. In this case it is extremely important that the fluid product should be delivered in its most concentrated form, particularly so if it must be evaporated. While it is possible to dispose of weak washing liquors effectually by counter-current methods, it involves more plant, labor and losses.

THE THIRD TYPE OF PROCESS

We may illustrate the third type of process, namely, intermittent precipitation, filter-pressing and washing for the separation of solids and liquids, by the Kelly filter press, already installed in several pulp mills.

Chemical filtration consists in cake building and cake washing. If the cake retains valuable salts, they should be removed because of their value; if the cake carries the principal value, it should be washed to remove the impurities. The filter press is adapted to either case and the method of procedure is the same.

Plate and frame presses have been used in chemical operations for many years. They have given good results notwithstanding many deficiencies. In these presses, the cake is formed within the bag, cakes forming on the opposing faces until they grow together. The filtering capacity continually diminishes until the cake is formed, which will contain a moist core unless time is taken at the expense of capacity.

Such presses required much hand labor and are relatively of small capacity; the washing of the cake must be done by displacement of the unfiltered sludge, remaining within the press, and the filters themselves must be removed for cleansing. They are better adapted to problems in which the cake is the more valuable product, and not well adapted for such work as filtering hot strong caustic solutions.

IMPROVEMENTS AS ILLUSTRATED BY THE KELLY PRESS

Recently, many striking improvements have been made which have furnished the motive for this report. The Kelly press illustrates many of these improvements in intermittent filtration. The essential parts of this press are:

(1) The supporting frame.
(2) The press shell.
(3) The filter carriage.
(4) The filter leaves.
(5) The quick-locking head mechanism.

The press is telescopic in design. The filters are inclosed in a tight shell and the cake is built up uniformly upon the outside of large filter bags whose area is not diminished in the process of forming the cake. The filter leaves are built up frames, carrying a four-mesh wire screen, and are entirely inclosed within the bags. They are connected to the head end of the press and discharge their filtrates into a common trough. This whole mechanism, including the head end, is counterpoised on a sloping frame. When in operation the filters are inclosed within the shell, and when ready to be discharged they are withdrawn.

Briefly, a complete cycle of operations consists in pumping the sludge into the filter, under a controllable pressure, until the cake is formed. The unfiltered sludge is then displaced by air pressure and this in turn replaced by air pressure, and this in turn replaced by wash water or other washing media. These operations follow successively under a constant pressure so that the cake may be retained intact until the operation is finished. Whenever it is desired, the cakes can be further dried with steam or air. The press is then opened and the cakes can be removed easily by inflating the bags with air or steam, etc.

Some of the peculiar advantages claimed for this press are:

(1) Large capacity for space occupied and time consumed.

(2) Economy in energy, including mechanical power, manual labor, losses of energy by changes of temperature during the process.

The shell of this press can be insulated against radiation, either by steam jacket, lagging, or means for circulation brine so that the process can be controlled at any temperature desired.

(3) Economy of extraction with a minimum of wash water.

(4) Presses are built strong with a good resistance to wear and tear.

As applied to the soda pulp process, the strong sludgy liquor should be discharged from the causticizing unit into a tank where one sedimentation and one decantation of the strong liquor should be made. The strong

liquor sludge should then pass directly to the filter press, and the strong filtrate pass on with the strong decanted liquor. The largest product of strong liquor will be obtained. The cake may then be washed and the small volume of weak liquor be disposed of in the usual way. The cake itself is then ready to be discharged. There are many of these presses in use for handling caustic soda sludges, both in pulp and chemical works.

CONTINUOUS FILTRATION

Under the final subdivision of this report we shall deal with continuous filtering.

The actual chemical operation of causticizing may be either intermittent or continuous, though I see no particular advantage in the continuous plan. The batching plan provides for definite quantities per batch, with definite results; the continuous plan involves a definite proportional rate of flowage of all the elements entering into the system per unit of time, and requires more intelligent supervision.

In either case and by any system I would advocate one sedimentation and decantation of the strong liquor as the simplest means for separating the bulk of the strong liquor. Or, if a tank of the "Boston tank" design is used, the causticizing unit may discharge directly, in a continuous flow, into it.

In its simplest form the Boston tank consists of a cylindrical tank with conical bottom, having a distributing trumpet in the center, through which the sludgy liquor enters and at the bottom of which the sludge settles, while the clarified liquor rises to the top and flows away through an annular collecting gutter. A pipe situated at a suitable level provides for the continuous discharge of the sludge to the filter.

The Boston tank is a variation of the Dorr thickener to obtain similar results, and may be used in series for counter current separation of the solids. It is introduced here because it forms part of the system advocated by the Industrial Filtration Corporation, which is a builder of continuous filters.

The rotary continuous filter consists of an open container, in which is suspended a revolving drum, whose periphery is composed of a number of shallow compartments covered by a filtering medium. Each compartment, by means of individual pipe lines, is connected to a perforated trunnion, which turns against a stationary valve cap, to which are attached suction and blow lines. The arrangement is such that suction and air pressure may be applied at different points to each of the compartments during every revolution of the drum, the cake forming on the surface by the suction and discharged at the proper time by the air pressure. It may also be removed by a scraper, or doctor blade. The clear filtrate passes through the connecting pipes to the discharge through the trunnion. The filter is in many respects a combination of the cylinder mold and the revolving suction roll, well known in the paper industry.

Provision is also made for washing the cake and separating the wash water from the strong filtrate. The cake discharges with 35 per cent to 40 per cent moisture.

The one notable thing which has made possible these great improvements in filtering devices is the invention of a metallic filtering cloth capable of resisting corrosive action and woven in such a way as to give a clear filtrate.

The filtering drum of this continuous filter is covered with such resisting wire cloth, made of Monel metal.

These continuous filters are being used with good results in many large pulp and paper works and chemical industries.

BUILDING, FLOOR SPACE, POWER AND LABOR REQUIRED TO INSTALL AND OPERATE THESE DIFFERENT TYPES OF PROCESSES

Taking as a basis a mill producing about 100 tons of pulp from poplar wood, the actual alkali required to be causticized daily would exceed 125,000 lb., by the losses incurred in the process. This would approach 100,000 lb. of caustic and be contained in about 160,000 gal. or 21,400 cu. ft. The amount of calcium carbonate resulting from the chemical reaction would be about equal to the amount of alkali, since their molecular equivalents are nearly the same.

To install a sedimentation and decantation process would require a tank floor space of 15,000 sq. ft. provided only one tank volume is turned out every 24 hr. A tank should make two complete cycles daily and in this event the floor space would be reduced half, or 7500 sq. ft. This alone would call for a building 75 ft. by 100 ft., allowing no room for operating. Additional tanks for weak liquors and storage or miixng of cooking liquor must be provided and means for the final disposition of the sludge.

The building should be of good height, not less than 40 ft., and all above ground to secure good light, ventilation and drainage. There should be an upper inclosed deck or gallery to contain the causticizers and a storage of lime conveniently located.

These tanks must all be equipped with agitators and power to drive them. It would probably require an equipment of 100 hp. from capacity to operate such a system, though the actual power required for most of the time would be very much less. It would require three men to operate this part of the plant.

A causticizing plant, according to the Dorr system, would occupy a space approximately as follows:

These are built in 10 tons of caustic soda units. Each unit requires a floor space of 75 ft. by 26 ft. It would require five such units for a production of 100 tons of poplar pulp or 50 tons of caustic soda daily. This would call for a floor space of 75 ft. by 130 ft. It is possible to reduce this floor space by using tray thickeners. These consist of one or more steel trays placed in a settling tank with a set of arms and plough blades for each tray all operated by the same vertical shaft. Such tray thickeners were installed in the Kingsport plant. No additional space would be required for weak liquors since the counter current system provides for this, and no pumps other than the small diaphragm pumps are required.

The total power required for each unit is 5 hp. One man only would be required to operate the whole five-unit plant.

A DIFFERENT BASIS FOR AN ESTIMATE OF CAPACITY

In proposing a system for making liquors where a filter forms an essential element, the capacity of the filter must be the basis. Choosing the Kelly press as one type, two single units, type No. 450, or one twin unit, type No. 1300, would be required.

The floor space occupied by the single press is 5½

ft. by 23 ft. each. Additional space must be provided for tank supplying the presses, for pumps, air compressor and operation.

The presses must be situated at an elevation which will permit of automatically discharging the cake into a hopper and thence to a conveyor beneath. Probably 50 hp. and the services of two men would be ample to operate.

It will thus be seen that the building and floor space for such a plant would be relatively small, the idea being to make as complete a separation of solids and liquids by forced filtration of the original liquor rather than by a progressive separation by dilution of the residue which requires large tank capacity.

The rotary continuous filter operating on strong caustic sludge would receive the sludge from a continuous settling tank as described above. Two of these filters would be required and should be placed with their discharge sides facing each other so that the cake may pass to a common conveyor. These filters occupy a space 8 x 8 x 8 ft. and weigh about 11,000 lb. each.

The filtering drum revolves about 1/3 r.p.m. The only power required for this work would be for an exhaust pump which would act as a blower at the same time to lift the cake over the doctor and for the conveyor. Practically no labor is required, as the process is automatically continuous.

Such then are the essential features of the latest devices and processes for causticizing sodium carbonate liquors with lime for the efficient separation of the calcium carbonate from the caustic liquor.

RELATIVE MERITS AND EFFICIENCY ON THE DIFFERENT CAUSTICIZING SYSTEMS

In discussing the relative merits of the different processes used in the soda pulp mills for changing the sodium carbonate to sodium hydroxide, and their efficiency as regards steam consumption and alkali accounted for, it is necessary to form some basis of efficiency. In the older decantation process, in most general use, time and capacity are the principal efficiency factors.

An alkali room having ten pans (each of such capacity that when charged with sodium carbonate liquor, causticized, properly settled, drawn off and mixed with a properly settled first wash, there will be enough liquor for two digesters) is capable of furnishing liquor enough for twenty digesters in twenty-four hours. In other words, each pan should be allowed twenty-four hours for one complete cycle in order to obtain good economical results. This will allow the strong and first wash each four and a half hours and each of the other three washes three hours to settle before syphoning off the clear liquor. When handled in this way the lime sludge discharged will contain about 85 per cent weak liquor and 15 per cent solids by volume, or 68 per cent weak liquor and 32 per cent solids by weight. The loss of soda in this sludge discharge will be from ½ to ¾ per cent of the total soda used.

Thorough agitation is also a necessary factor in causticizing soda efficiently. If the agitator shaft is provided with one set of wings near the bottom, it should make at least 30 r.p.m.; but provided with three sets of wings at three different heights, the speed of the shaft can be cut to 16 or 18 r.p.m. and give equally good results. Of two mills using the same size alkali pans, the same quantity of lime, and all other conditions the same, excepting the speed of the agitator shaft, the shaft in one mill made 20 r.p.m. and in the other 30 r.p.m., with the result that the former was obliged to use about 8 per cent more lime than the latter; and, on account of using extra lime to get the same causticity, 6 per cent less liquor was syphoned from the strong pan in the former mill, after allowing the pans to settle the same length of time.

When using a lime containing 94 per cent active calcium oxide, it is customary to use about 560 lb. of lime for each 1000 lb. of sodium carbonate causticized, in order to get a strong liquor having 92 per cent of the total soda causticized. This strong liquor when mixed with a first wash of 97 per cent causticity will furnish liquor of about 94.5 per cent causticity for the digesters. The lime when slacking in the pan of carbonate liquor will furnish about 480 B.t.u. per pound or 268,800 B.t.u. for every 1000 lb. of sodium carbonate causticized. This will raise the temperature of the liquor about 30 deg. Fahr. If the carbonate liquor from the leachers tests 160 deg. Fahr., the lime added will raise the temperature to 190 deg. Fahr., so that it is only necessary to add enough steam to raise the temperature 22 deg. higher to reach the boiling point at the sea level. It is only necessary to boil the pan of liquor about 15 min., when the agitation is good; but agitation should be continued from 20 to 30 min. longer.

At this point I might mention the part the quality of lime plays in affecting the time necessary to boil the liquor. The calcium oxide content of a lime, as found by analysis, very often comes far from representing the active content of the lime. Samples of lime with a total calcium oxide content of 85 per cent have shown an active content as low as 72 per cent. The Soda Pulp Committee, in a previous report, has called the attention to a miniature causticizing test as a satisfactory method of testing lime used in order to determine its active content. The principal cause for the difference between the actual and active calcium aside from that present as carbonate is due to presence of an excessive amount of silica and alumina in the form of silicates, which has been fused by overburning in the kiln, and incloses some of the active lime, making it difficult for the slacking water to reach it. Lumps of this lime will stand in hot water as long as 25 min. without breaking down, while a lump of good slacking lime will break down completely in about 1 min. It will be found advantageous to make a rough slacking test, as above suggested, in the alkali room, when a car of lime appears refractory; and if it requires much time for the lumps to break down better results can be obtained by boiling the pans of liquor an additional half hour. By the decantation process, allowing 24 hr. for one complete cycle, 8 lb. of sodium carbonates can be causticized per cubic foot of pan capacity in 24 hr.

Most of the soda pulp mills have increased their production to such an extent that the alkali room is worked far beyond its capacity; and the result is inefficient operation in this department. The original ten pans are trying to do the work of fifteen, which results in cutting the cycle of time to 16 hr. in place of 24, and causing a loss of from 3 per cent to 4 per cent of the total soda causticized.

The newer processes brought forward in recent years cannot be considered substitutes for the causticizing

process, as the first step in the operation is the same in every case. The sodium carbonate must first be causticized by boiling with lime. It is from this point on that improvements have come to the assistance of the soda pulp manufacturer. By a small addition to his alkali room he is able to secure, with the same number of pans, an increase in capacity of 100 per cent to 150 per cent. The improvements consist in new methods of separating the liquor from the sludge after the causticizing process is finished, effecting a saving of time and space and cutting down the loss of soda in the sludge discharges. A description of such methods has been given in the earlier part of this report, and a brief abstract of their principles and claims will now be given. By a small addition to his alkali room he is able to secure, with the same number of pans, an increase in capacity of 100 per cent to 150 per cent.

The Dorr process is an improved method of doing on a systematic continuous plan what is attempted with a discontinuous intermittent system of disconnected tanks. The process being strictly counter current, it is very efficient in washing the precipitate, sustaining and building up concentrations from the washings.

The Dorr Company's engineer reports that the Kingsport plant, having a capacity of 50 tons dry weight of caustic soda a day, producing 14 deg. Baumé liquor of 92 per cent causticity, has an efficiency of 99.4 per cent The process is well illustrated and results are analyzed on the "flow sheet." As such it is a decided improvement upon the old system.

There is one important matter which should not be overlooked. The system is not well calculated to retain the initial heat, since the thickeners are very large and shallow. Large open tanks containing hot liquors should be covered or the condition of the room will be very disagreeable, particularly in a cold climate, and there will be large heat losses.

The obvious purpose and intent of the filter-press, however designed and operated, is to effect a thorough and rapid separation of solids and liquids, thereby obtaining a clear filtrate and a clear solid mass in the shortest time, with the least expenditure of capital and labor. The filter press, generally speaking, produces a cake when operating on this caustic sludge, containing about equal parts of solids and liquids, and when washed with a volume of water equal to the cake the caustic losses with the cake are 1 per cent and under. Therefore that system of forced filtration, which will take the hot boiling sludgy caustic liquor from the causticizer, of the desired strength, and effect a prompt and thorough separation, with the least expense for equipment and maintenance building, power and labor, is the system desired. If therefore the intermittent or continuous forced filter will accomplish this, obviously such a system has distinct advantages over any sedimentation plan.

It will, of course, require a higher degree of skill and intelligence to operate the more complicated and highly organized filtering machine than the foolproof old system of sedimentation and decantation in tanks. If we are content with slow, crude and cumbersome methods, we shall choose this. If, however, we want to be leaders in chemical processing, there is much to commend in the newer methods of forced mechanical filtration, intermittent and continuous.

Every problem involving a separation of solids and liquids has its individual and peculiar features, and we should join with the designers and builders of chemical appliances in solving our mutual problems. This meeting and our association are organized for just such problems.

Synopsis of Recent Metallurgical and Chemical Literature

Electrochemistry

Electrochemical Industries of Italy.—*The Chemical Trade Journal and Chemical Engineer*, Sept. 22, 1917, prints an account of the electrochemical industries of Italy, taken from *Zeitschrift für Angewandte Chemies* (date not given). The account states that the numerous sources of waterpower in Italy, especially in the north, have contributed largely to the extension of the electrochemical industry, which is mostly established in Lombardy. The Societa Anomina Ferriere di Voltri of Darie, in the Province of Brescia, have worked a calcium carbide plant since 1908, using waterpower from the Dezze. The furnaces work continually and can produce four tons of carbide daily. Another electrochemical works in Lombardy is the nitric acid factory of the Officine Elettrochimica Dott Rossi of Legnane, which, like the factory of Patsch, near Innsbruck, uses the Pauling method, and obtains the nitric acid by conversion of atmospheric nitrogen. Besides nitric acid, potassium chlorate is also manufactured, which has greatly reduced the amount formally imported from France and England. The yearly production for the year before the outbreak of war was 12,000 tons of 36-42 deg. Be. nitric acid, and 580 tons of potassium chlorate.

In Pidemont the Societa Industriale Elettrochimica di Pont Saint Martin, which was established in 1899, produced calcium carbonate for many years. In the same locality, the Societa Pidemontese for the manufacture of calcium carbide and allied products with a working capital of 2,000,000 lire has a plant for the manufacture of calcium carbide and nitrate of potash which is worked by waterpower from the Dora Baltia. For the manufacture of calcium carbide two Tofani furnaces of 2500 and 1200 hp. are used, and suitable lime is obtained from the Meana di Susa quarries. The yearly production is about 2400 tons. Part of the calcium carbide produced is used in the manufacture of calcium nitrate, according to Linde's German method, the yearly production being now 2900 tons; ferrosilicon, silicium and barium sulphate are also manufactured. In summer the plant works uninterruptedly day and night, while in the winter, on account of the shortage of electric current, it is only worked at night.

In the Umbrian provinces there are a number of important works, of which two produce electric power exclusively. The Societa Italiana per il Carburie di Calcio (capital 14,000,000 lire) erected the first Italian calcium carbide factory in 1896, using waterpower from the Velino. They possess at present the three works at Collestate, Papigno, and Narni, with their own electrical stations. Most of the electric energy produced is used in their own works. The Collestate works have been in operation since 1897, and at first manufactured calcium carbide. In the year 1908 the

manufacture of calcium cyanamide was commenced, and the output of calcium carbide declined. Nitrogen is obtained directly from the air by two plants, the first producing 125 and the second 400 cbm. per hour. This factory delivers 15 tons of calcium nitrate daily, together with 15 tons of ammonia sulphate. The Papigno calcium carbide factory has a capacity of 60 tons daily, and produces over two-thirds of the company's production of calcium carbide. The carbide is made by a special process which this firm has patented. The Narni calcium carbide factory was taken over by this company in the year 1908. The factory has a capacity of 40 tons daily.

Two further calcium carbide factories, which do not belong to the above-mentioned company, are to be found in Foligno and Salifano. The factory in Foligno, belonging to Fabbrica Italiana di Carburie Derivati, has greatly reduced its output of calcium carbide in recent years, and has taken up the manufacture of barium sulphate and barium oxide as well as sodium sulphate experimentally. The electrical power is supplied by the Foligno municipal electrical depot. In Salifano there is also a similar plant for the manufacture of calcium carbide. In the Abruzzi the Societa Italiana di Elettrochimica has a chemical works situated on the Rome-Castellamare Adriatic railway, and employs 400 hands. The electrical power is obtained from stations at Ticino and at Primo Salto del Pescara. The plant produces about 3400 tons of caustic soda yearly from rock salt, which is obtained from Sicily. A further 250 tons of sodium chloride is obtained as a by-product of electrolysis. Further 5000 tons of calcium chloride, 500 tons of very pure hydrochloric acid, and 50 tons of carbon tetrachloride are produced. 1200 tons of 50 per cent iron silicate are manufactured yearly by the electrothermic process, using two monophase furnaces of 715 hp. each, and in a triphase furnace of 1500 kw. about 4000 tons of calcium carbide are produced. The consumption of these products is limited almost exclusively to Italy. A factory belonging to the Societa Industriale Italiana of Capistrella (Aquila) also manufactures calcium carbide.

Gas Industry in Wartime in England.—J. H. Brearley presented a paper on "Wartime Experiences of Gas Undertakings" at a meeting of the Eastern Counties Gas Managers' Association, held in London, about Oct. 1. The paper is abstracted in the *Chemical Trade Journal and Chemical Engineer* and gives important and interesting information. The author said that, taken as a whole, the residual products could not be said to have contributed as much toward working costs as might fairly have been anticipated. Coke had been satisfactory, for the simple reason that, with few exceptions, its sale had been unfettered. Tar for a long time remained a source of anxiety on account of the difficulty experienced in dealing with pitch. Various works experimented with pitch for gas-making; but today little was heard of that method of keeping production within manageable limits, and it seemed to have fallen largely into desuetude. Creosote, from being almost an absolute drug, had become one of the most important distillates; and for its recovery in adequate quantities the greater production of tar was urgently called for. The requirements of toluol and benzol were being adequately met. An incidental result of the process of recovering benzol by washing the gas with creosote oil had been to discredit finally the illuminating power test as applied to gas undertakings.

Home demands for munition-making had taken large quantities of concentrated ammoniacal liquor, estimated in 1916 as the equivalent of over 70,000 tons of sulphate of ammonia. In the same year the home consumption of sulphate of ammonia was 178,500 tons, as compared with 128,000 tons the previous year. There were exported 259,500 tons.

The figures at which maximum prices were fixed for sulphate sold to farmers had given very general dissatisfaction among producers. Although they hoped and expected to see the home demand for sulphate grow greatly, their organizations would have to fortify themselves against the powerful influences which the farmers appeared able to invoke if the time ever came when they had to rely solely upon the home markets. Unless circumstances altered, they could not view as an unmixed blessing a state of affairs in which they were permamently cut off from all export markets. For the time being the advent of war had effectively countered the German efforts to capture the world's markets. When the war was over, British producers might reasonably hope to command a fair share of the foreign trade, if sulphate maintained its position in comparison with other sources of nitrogen. Doubtless the Sulphate of Ammonia Association was looking ahead, and formulating their plans accordingly.

The maximum price fixed for sulphuric acid was much higher relatively than that fixed for sulphate of ammonia. Spent oxide, however, had commanded good prices, and afforded a substantial set-off. The use of nitre-cake for sulphate-making did not appear to have been a success.

Mr. Thomas Glover, in the course of the discussion, said there was a thought which was suggested by the president's address, and that was in reference to purification—the extraction of sulphur and the making of sulphuric acid. When this country went to war, its ability to produce sulphuric acid was very much below the necesities of the case; and as the submarine menace had developed, the difficulty of finding raw material for making sulphuric acid had increased. First it was plant; and then, secondly, it was raw material. Now the gasworks, very quietly and without it being recognized, had been producing a very large quantity of raw material for sulphuric-acid making. The conversion to oxide purification which had become almost general insured that sufficient sulphur would be extracted from the coal to make enough sulphuric acid to neutralize all the ammonia which was also produced from the coal. And in addition to this, a very considerable excess of sulphuric acid was produced from the sulphur extracted from the coal which they carbonized. They had not in the Eastern Counties many large works in which it would pay to put down a sulphuric acid plant to burn their own oxide; but it was possible to make advantageous arrangements with a chemical works to take the oxide, burn it, and supply the sulphuric acid to the gas works for sulphate of ammonia manufacture, and also to return the burnt material to the works. It could by suitable means be rehydrated, and brought back into service; and so the process could go on continuously. It was a thing which, if properly worked, under suitable conditions, could be made to pay the whole cost of puri-

fication and leave a little margin of profit. With reference to the price of sulphate, he agreed with the president that the price fixed by the Government was an unfair one, and that the industry was not called upon to subsidize agriculture—to the great advantage of agriculture, and to the disadvantage of the gas industry. With the price of sulphuric acid so high, the price of sulphate of ammonia should have been fixed higher. Something, too, might be said of the prices paid for benzole and toluol, which were rather below pre-war rates.

Mr. W. W. Townsend said it seemed to him that the direction in which progress was to be looked for in the future was in making coal gas of decent quality, at a moderate temperature, getting good yields of ammonia and oils, and stretching it to get the required quantity by the addition of blue water gas.

Heat Insulation

Comparative Tests of Heat Insulating Materials.—Some interesting tests were recently completed by Sargent and Lundy, consulting engineers, of Chicago, on the relative value of various heat insulating materials. The report was published in *Power*, May 1, 1917.

The first object of the tests was to determine the relative thermal insulating value of the materials examined. The materials were obtained in or were cut to the dimensions of standard bricks, so that in this respect the samples were equal.

The difficulty, which was expected, was found to be in insulating thoroughly the top, bottom and sides of the bricks. Naturally, it is difficult to insulate a material that is itself a good insulator. From these tests there did not appear to be so much difference between the fire and the insulating bricks compared by this method of temperature gradient, and it might be said that, roughly, 6 in. of firebrick is equal to 4 in. of insulating brick, which on general principles is not reasonable.

It is pointed out that, though every precaution was taken to insure comparative conditions, it follows from radiation laws that a very small difference, in various ways, such as the high-temperature source, thickness of insulation between samples, etc., might lead to wrong results and it is well known that magnesia is equal in insulating value to many times its thickness in ordinary firebrick, so long as disintegration does not take place.

It was therefore considered that some other method should be found to obtain a more absolute comparison and that it should be on the basis of measuring the actual quantity of heat passing through the material under test. This would be a true value of the heat-insulating value of the materials.

The method adopted was to build a furnace of the various materials, cut to the dimensions of standard bricks and carefully laid up with small joints. These furnaces were heated by means of an electrical heater made of arc-lamp resistance coils and arranged to evenly distribute the heat over the inside. The electrical energy can be measured with great accuracy and could be exactly adjusted. The electrical input to the heater was converted into B.t.u. by multiplying the watt-hours consumed by 3.412, as it was thought advisable to use the B.t.u. as the unit of heat and not to express it in electrical units.

If the electrical input is constant, then the temperature will rise in the furnace until the temperature difference between the inside and outside is sufficient to cause the heat generated to be dissipated at an equal rate; then equilibrium is established. On established equilibrium, readings were taken of the electrical energy and the temperature of the inside and the outside of the furnace. By varying the electrical energy a curve can be drawn between the temperature difference of the inside and the outside of the furnace, and the B.t.u. radiated per hour. By this method of testing it is easily seen the great advantage, from a thermal point of view, the insulating materials have over the ordinary firebrick.

To express this variation in insulating value with the temperature, it was thought that a similar relation to Ohm's law might be found. This was proved to be so. The unit taken has been called the "thermal Ohm" and is expressed by dividing the temperature difference by the B.t.u. radiated per hour. The values for the materials have been calculated and these show practically straight lines except for magnesia and a combination of sigur and magnesia, marked Si.-Mag. With this latter material the "thermal resistance" decreases directly as the temperature difference.

To use the figures thus obtained, to find the equivalent thickness of material required to give equal insulation—that is to say, equal thermal resistance, in each case—it is necessary to demonstrate experimentally the laws of thermal resistance. To do this, furnaces of half and twice the thickness of the original furnace were built and tested.

The results proved that the thermal insulation is directly proportional to the thickness.

The material of highest thermal resistance is Sil-O-Cel; the other materials are therefore expressed in terms of this material.

At 2000 deg. F. the relative values are as follows:

1 thickness of Sil-O-Cel equals:	6.5	thicknesses of Osceola firebrick.
	1.85	thicknesses of Diddier insulating brick.
	1.65	thicknesses of Si.-Mag. insulating brick.
	1.35	thicknesses of Sigur insulating brick.
	1.20	thicknesses of Nonpareil insulating brick.

From the known dimensions of the furnaces the B.t.u.'s radiated per hour square foot of surface for various temperature differences are figured. Under similar conditions a Sil-O-Cel wall would radiate 22,250 B.t.u. per hour, or only about 20 per cent as much as the firebrick wall. The following crushing tests are also interesting:

CRUSHING TESTS OF HEAT-INSULATING MATERIALS

	Before Heating Lb. per Sq. In.	After Heating Lb. per Sq. In.
Sigur	357.6	339.7
Sil-O-Cel with strata	171.6	168.0
Sil-O-Cel against strata	404.4	379.0
Sil-O-Cel average	288.0	274.0
Magnesia	144.0	Crumble easily
Diddier	39.3	
Nonpareil	183.0	168.0

As these tests required a week or two to complete on each furnace, it was no measure of what effect "aging" would have on the material. For this reason furnaces of Sil-O-Cel and Sigur were built and run at temperatures of 1200 deg. F. respectively for over six months continually, with no change in the insulating properties whatsoever and with no damage to the materials themselves.

Recent Metallurgical and Chemical Patents

Dyestuffs

Chromium Compounds of Azo Dyestuffs.—Gadient Engi and Carl Jagerspacher of Basel, Switzerland, patent a chromium dyestuff and process of making same. The patent is assigned to the Society of Chemical Industry of Basel. The product is made by treating an orthoaminophenol compound with a chromium compound in a hot aqueous medium, diazotizing the chromium compound of orthoaminophenol compound, combining the resulting chromium compound of orthooxydiazobody with a naphtholic compound and treating finally the thus obtained half chromated orthooxyazodyestuff in a hot aqueous medium with a chromium compound. The dye is stated to undergo no change by adding sodium carbonate or soda lye and to produce fast tints on animal fibre which are not changed when subsequently chromated. (1,242,536, Oct. 9, 1917.)

Disazo Dyes.—Rudolf Schüle of Frankfort-on-the-Main, Germany, patents a new disazo dyestuff and process of making it. The patent is based upon the discovery that by combining the diazocompound obtained from diazo-p-nitrobenzene and aminocresolalkylether

$$(CH_3:NH_2:OR=1:3:4)$$

where R denotes an alkyl group and further diazotation with M-aminophenyl-8-oxy-1.2.naphthimidazole-3.6-disulfonic acid in alkaline solution, a disazodyestuff is obtained which dyes cotton bluish black shades; these may be developed on the fiber, yielding brilliant green shades by further diazotizing and developing with 1-phenyl-3-methyl-5-pyrazolone, phenol, cresol or resorcinol. Brilliant green shades are likewise obtained by after treatment with p-nitrodiazobenzene. The developed dyeings are stated to be of good fastness to washing, soap and light. (1,241,153, Sept. 25, 1917.)

Copper Compounds of Orthooxyazo Dyestuffs.—Gadient Engi and Carl Jagerspacher of Basel, Switzerland, patent a process for the manufacture of copper compounds of orthooxyazo dyestuffs. The patent is assigned to the Society of Chemical Industry of Basel. The patentees have found that instead of starting from the orthooxyazo dyestuffs and acting with copper compounds on their solutions, the new copper compounds can also be obtained by effecting the combinations of orthooxydiazophenol-or orthooxydiazonaphthol derivatives with azo dyestuff components, in presence of copper compounds. Thus the copper compounds of the orthooxyazo dyestuffs are produced directly and can be isolated eventually after addition of common salt, by filtration, washing and drying. The process is described in the specifications. (1,237,183, Aug. 14, 1917.)

Leucotriarylmethane Dyes.—Fritz Funcke and Carl Jagerspacher of Basel, Switzerland, patent new dyestuffs and a process of making same. The patent is assigned to the Society of Chemical Industry of Basel. The dyestuffs are obtained by diazotizing the amidoleucopatentblue, resulting from the nitration of leucopatentblue and the subsequent reduction of the obtained nitro derivative, and by combining the prepared diazo body with an azo dyestuff component, as for instance an amine, a phenol, a naphthol, an aminophenol, an aminonaphthol or their sulfo or carboxyl derivatives, pyrazolone derivatives, etc. The dyestuffs dye on mordants and are therefore stated to be especially applicable for dyeing animal fiber vivid blue to green tints, fast to washing and light, according to the methods usually employed for the dyestuffs which dye on mordants or are able to be chromated on the fiber. They constitute blue to green and yellow powders, soluble in water, with blue to green and yellow colorations and in concentrated sulfuric acid with yellow to violet colorations. (1,237,192, Aug. 14, 1917.)

Copper Compounds of Leucotriarylmethane Dyes.—Another patent of the above parties deals with copper compounds of the above dyes. These dyes are transformed by treatment with copper oxide or copper hydroxide, in an aqueous medium into new copper compounds soluble in water and dyeing animal fibers in an acid bath vivid blue to green tints fast to light, washing and alkali. The new copper compounds constitute blue to blue and green powders, soluble in water with blue to green coloration and in concentrated sulfuric acid with green to red colorations. (1,237,193, Aug. 14, 1917.)

Copper Compounds of Orthooxyazo Dyes.—Barthold Wuth and Carl Jagerspacher of Basel, Switzerland, patent a process of making copper compounds of orthooxyazo dyes. This is the process mentioned in above patent 1,237,183. The latter being a variation of this present patent. The present patent refers back to a previous application. It describes the transforming of orthooxydiazo dyestuffs derived from orthocarboxylated benzoylacetic acid into new copper compounds by treatment with copper oxide or hydroxide. (1,234,994, July 31, 1917.)

Azo Dyes.—James H. Stebbins, Jr., of New York City, patents new azo dyes and methods of making same. The new dyestuffs are derived from 1.8-dioxynaphthalene-3.6-disulfonic acid, otherwise known as chromotropic acid, by combining this acid with diazotized benzidin, or its equivalent, and with another diazotized aromatic amin, such as diazotized para-nitranilin or diazatized para-amido-phenylglycin or diazopicramic acid; and by further combining with the diazotized benzidin an end component such as 1.5-naphtholsulfonic acid or the 1.4-naphtholsulfonic acid. The dyes are soluble in water and capable of dyeing both wool and cotton without mordants. (1,235,253, July 31, 1917.)

Nitrogen Fixation

Concentration of Nitric Acid.—Kristian Birkeland, Christiania, Norway. Process of concentrating the dilute acids obtained by the absorption of nitrous gases, more especially from such nitrous gases as are obtained by the direct combination of air nitrogen and oxygen. According to the patent, the concentration of the dilute acid, which usually has a strength of about 30 per cent, is effected by producing, by means of the acid, a nitrate of a metal and subsequently decomposing the nitrate by treating it with superheated steam and condensing and further treating the vajors so obtained. (1,236,662, Aug. 14, 1917.)

Apparatus for Iron, Coke, Soda-Ash Process.—Ralph H. McKee, Ridgefield Park, N. J. Patent relates to a container having interior walls of an alloy of 50-60 per cent nickel, 10-20 per cent chromium, and 10-30 per cent manganese and carbon. Container is stated to exert a favorable effect on the reaction when nitrogen is passed over coke, iron oxide and soda ash for nitrogen fixation. (1,236,853, Aug. 14, 1917.)

Calcium Cyanamid.—JAMES H. REID, Newark, N. J. This patent relates to the fixation of nitrogen and the making of metal cyanamids, and comprises combining nitrogen with metal and carbon by exposing metal carbide to the action of nitrogen and heat in such a manner that the carbide is supplied to the nitrogen at a temperature sufficient to elevate the nitrogen to a point selective to its combination or reaction and fixation and particularly by introducing molten metal carbide, such as calcium carbide, into nitrogen and performing the fixation of the nitrogen upon cooling of the carbide to a selective combining point, with the simultaneous heating of the nitrogen to the initial combining point. (1,241,020, Sept. 25, 1917.)

Nitrogen Fixation with Manganese.—LELAND L. SUMMERS, Chicago, Ill. Process consists in preparing nitrogenous compounds from the nitrogen of the air or other gaseous sources by the use of manganese or its compounds. A compound containing manganese such as the common dioxid of manganese, "pyrolusite," is heated in the presence of carbonaceous matter to form various carbides of manganese. While this reaction is in progress, nitrogen from the atmosphere or other sources is introduced and a reaction takes place, causing various compounds of nitrogen, carbon, oxygen and manganese to be formed, which may be readily recovered as such or as other compounds containing combined nitrogen in an available form. The process is conducted in an electric furnace. (1,242,264, Oct. 9, 1917.)

Inorganic Chemicals and Miscellaneous Products

Phosphoric Acid.—WM. H. WAGGAMAN, HARRY BRYAN and C. R. WAGNER, Washington, D. C. (Patent dedicated to the public.) New apparatus for making phosphoric acid and its compounds. Consists of a blast furnace (Fig. 1), provided with an inner or charge chamber, *B*, surrounded by, but discharging into, an outer chamber, a platform below the charge chamber for receiving the discharge from the same. Means is provided for introducing air into the outer chamber for introducing air into the outer chamber for burning and smelting the charge upon said platform and smelting the charge upon said platform. For introducing a further quantity of air into the upper part of the outer chamber in order to oxidize further the volatile products of the reactions the nozzles *I* are provided. Means for withdrawing the products of the reaction from the outer chamber is provided at *G*. (1,241,791, Oct. 2, 1917.)

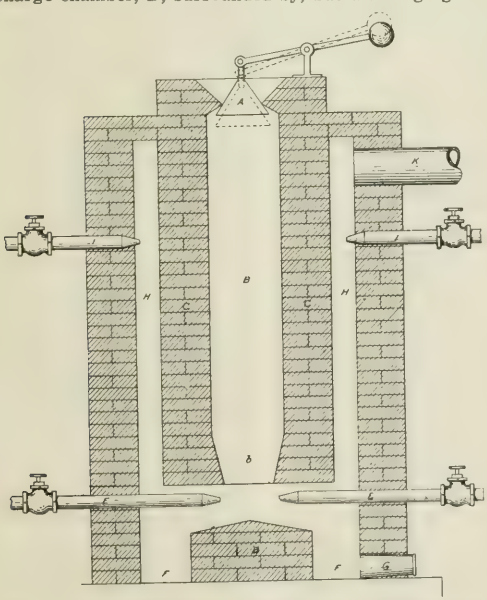

FIG. 1. BLAST FURNACE FOR PRODUCING PHOSPHORIC ACID

Case-Hardening Material.—A. O. BLAICH, Chicago, Ill. Assigned to A. O. Blaich Company, Chicago. Case-hardening material and process of making same, using ground charcoal or coke as starting point. This is forcibly submerged in a hot soda ash solution for a period of time and then dried in a revolving drum at 300 deg. Fahr. The mass is then sprayed with oil and mixed with calcium carbonate or barium carbonate. (1,241,909, Oct. 2, 1917.)

Aluminous Abrasive.—L. E. SAUNDERS and R. H. WHITE, Niagara Falls, N. Y. Assigned to The Norton Company, Worcester, Mass. An electric furnace product prepared by adding zirconia or certain of its compounds to bauxite or equivalent impure aluminous ores, the charge being then fused in the electric furnace and subsequently cooled either in the furnace or after removal therefrom. A small proportion of coke is added, sufficient to reduce the major portion of the iron oxide and silicon. No appreciable amount of zirconia is reduced. (1,240,491, Sept. 18, 1917.)

Organic Compounds

Phenol Condensation Products—K. TARASSOFF and P. SHESTAKOFF of Petrograd, Russia, patent a process of obtaining solid condensation products of phenols, formaldehyde and salts of sulfo-acids. The chief claims are as follows:

"Process of producing solid, infusible and insoluble phenol-aldehyde condensation products, comprising bringing together a phenol, formaldehyde, a salt of an alkaline reacting base and of a sulfo acid obtained in the sulfonation of crude mineral oil and an acid weaker than the sulfo acid, heating the mixture to start the reaction, removing the water that separates out, heating the residue on a water bath until the loss of weight reaches 70-75 parts by weight of the total amount of the materials employed, cooling the mass to 35-40 deg. C., adding a further quantity of formaldehyde, pouring the mass into molds, allowing the mass to remain at rest for some hours and then gradually raising the temperature of the mass to 100 deg. C." (1,237,599, Aug. 21, 1917.)

Amino-Oxy-Compounds.—ALFRED PIQUET, E. STEINBUCH and R. STOCKER, of Basel, Switzerland, patent an electrolytic reduction process which is assigned to the Society of Chemical Industry in Basel. According to the process amino-oxy-compounds are made by electrolytic reduction of aromatic nitrocompounds in acid, by employing as electrolyte in the cathode chamber a diluted acid solution which contains not much more acid than is necessary to combine with the bases produced by the reduction and in conducting the electrolysis in presence of at least two metals in the cathode chamber, which by continuously passing into solution and depositing on the surface of the cathode, maintain the latter always coated with a deposit of at least two metals. (1,239,822, Sept. 11, 1917.)

A New Blast Furnace Gas-Cleaning Machine

By John Ruddiman

The constantly increasing demand for higher blast temperatures has met with fairly good success through the introduction of gas cleaning devices of various types and principles, which permit the use of stoves with greatly increased heating surfaces, resulting from smaller checker passages.

But even with the best means employed for cleaning the gas, there is still something lacking to bring about conditions which operators regard as "ideal." Clean gas they must have, and get.

Clean, dry gas they prefer, and get only when atmospheric conditions permit.

Clean, dry, hot gas is their "ideal," and can get if they will follow the process only one step further.

Advocates of the dry and the wet processes of gas cleaning are still threshing out the question of superiority, moisture being the bone of contention; but in the end all must agree that the cleanest, dryest, hottest gas will furnish more B.t.u.'s at the tuyeres for a longer continuous period than will gas lacking in any one of these essentials.

The best of the dry processes, assuming that the dust content of the cleaned gas is satisfactorily reduced, furnishes gas retaining most of the sensible heat, and all the moisture it had on leaving the furnace. Because of the high temperature, it ignites at the burner in spite of the high moisture content, normally about 35 grains.

The best of the wet processes, while removing the dust to a satisfactory degree, furnishes gas cooled to near the temperature of the water, and usually supersaturated on leaving the cleaner. During its passage to the stoves a lower moisture content follows a drop in atmospheric temperature (the gas main acting as a condenser, requiring to be tapped and often cleaned), but the gas will still be at the saturation point on reaching the burners. Although of low moisture content (about 11 grains at 80 deg. Fahr.) the gas does not readily ignite, ignition usually taking place high up in the combustion chamber, hence a loss in heating surface in the stoves below the point of ignition which preheating of the gas would prevent. Preheating is not a new thought, but it has never been successfully applied in blast furnace practice. Recent developments in stove construction with the resulting high efficiency from small checkers prove that it can be economically applied. If two stoves with yet smaller checkers will accomplish better results than three, four or even five of the stoves in common use, and where the reduced temperatures of the waste gases will permit a suction fan to replace the draft stack, the saving in cost of construction would more than offset the cost of installing a preheating system.

By utilizing all the gas from the dust catcher for preheating the cleaned gas for the stoves, the reduced temperature of the uncleaned gas going to the cleaners will effect an economy in the water used for cooling purposes, while the portion of gas going to the boilers will still be of sufficient temperature to ignite at the burners without the use of coal, which is necessary when cleaned, cold gas is sent to the boilers.

The accompanying illustrations show two types of preheaters, either of which may be used in the layout shown, or connected up with any type of gas cleaners.

Type No. 1 in the layout is a combined heater and secondary dust catcher, and consists of a number of flues inclosed by two headers and part of the cylinder shell to form a heating chamber. This chamber is quarterly divided by vertical baffles arranged to form four connecting passages. A large central pipe, closed at the top by the header, and having an opening in its side at the top of the fourth passage, is connected by an elbow, below the bottom header, with a pipe horizontally carried through the dust chamber to a brick-lined stove main. The dust chamber is formed by the lower part of the cylinder shell, the conical bottom and bottom header. Two inverted elbows are attached to the cylinder near the top of the dust chamber; the large elbow, leading the twice dry-cleaned, hot gas to the boiler gas main; and the small elbow, leading the twice dry-cleaned, hot gas to the primary scrubber. Full details of the primary scrubber are not shown.

The appartus comprises either a square or rectangular tank having a hopper bottom for holding the waste water and a semi-circular cover which incloses a gas chamber into which opens the gas inlet pipe at one end and the gas outlet pipe at the opposite end. Passing longitudinally through the tank is a shaft supported and driven from without the tank by any suitable means. Stuffing boxes are provided to prevent the escape of gas at the points at which the shaft pierces the wall of the tank. Upon the rectangular mid-portion of the shaft within the tank is arranged a series of circular perforated baffle plates. Nozzles are fitted into the holes of each baffle plate, except the last of the series, the sum of the area of the nozzles in each baffle being slightly in excess of twice the area of the gas inlet pipe.

The baffle plates are suitably spaced apart along the shaft and secured thereto by flanges bolted to each baffle and having hubs, with set screws or keys, which serve to space the baffles apart. The baffles are supported in a vertical position and parallel to each other by ferrules on bolts which pass through the series of baffles at a convenient radial distance from the shaft and bind the baffles together when the nuts are set up.

The baffles have their nozzles so arranged that those of one baffle discharge against the blank interspaces on the following baffle so that the gas issuing from the nozzles in fairly close proximity to the adjacent baffles is brought into intimate contact with the blank spaces of the latter.

Spray pipes are arranged between the baffles and at the inlet and outlet ends of the gas chamber. The latter are designed to throw a spray upon the wall of the gas chamber to clean the latter, while the pipes between the baffles are so arranged that their jets are discharged against the adjacent faces of juxtaposed baffles and into the nozzles thereof, so that both the surfaces of the baffles and the interior of the nozzles are cleaned.

In this apparatus is combined the principle of the contact type of cleaner with that of the scrubber type. It is self-cleaning and economical in the use of water.

At the ends of the tank internal overflow troughs are provided, which maintain the normal water level of the water in the tank slightly below the center line of the shaft. A water seal is provided by waste pipes

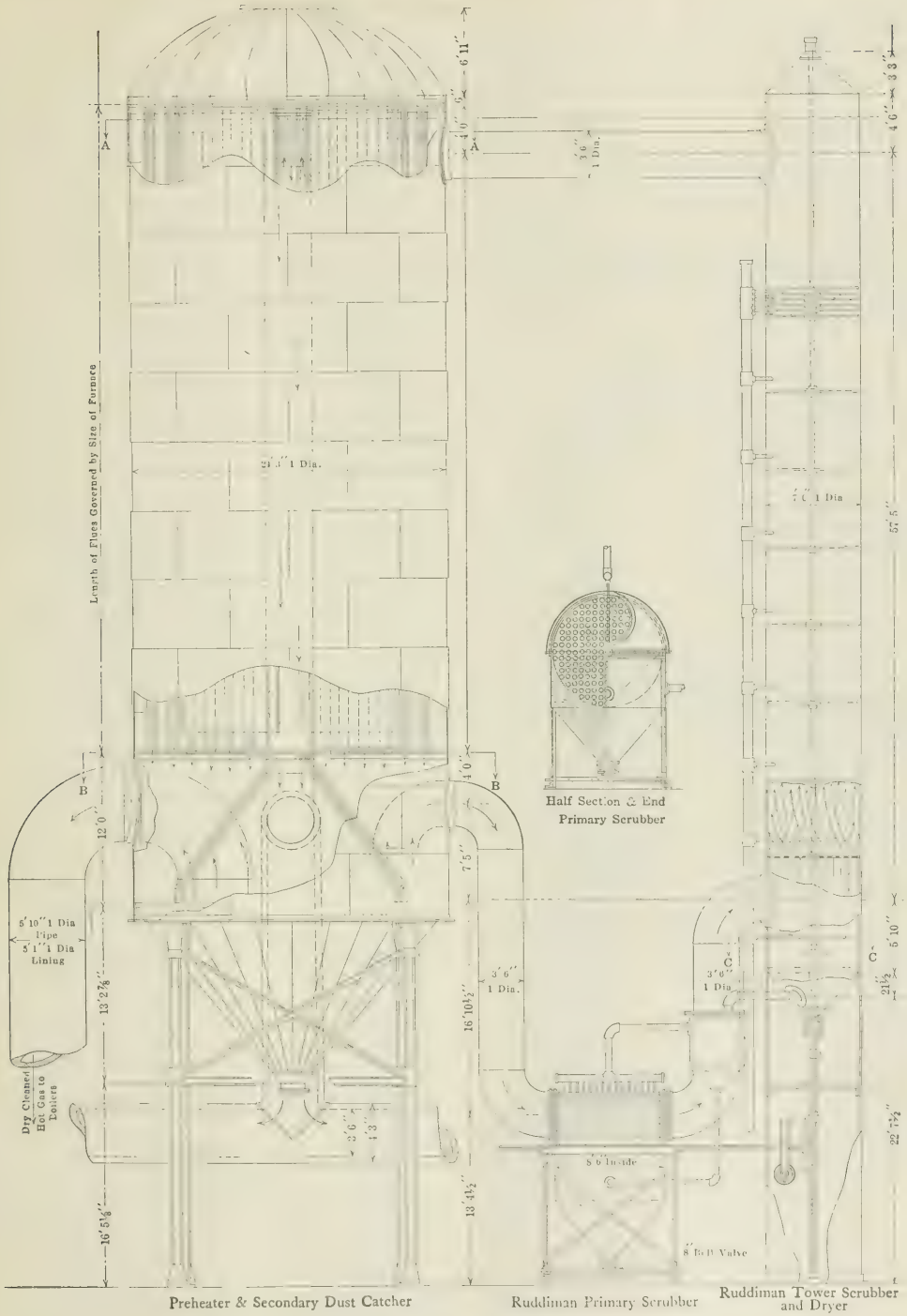
Length of Flues Governed by Size of Furnace
21' 3" 1 Dia.
5' 10" 1 Dia Pipe
5' 1" 1 Dia Lining
Dry Cleaned Hot Gas to Boilers
Half Section & End Primary Scrubber
7' 0" 1 Dia
3' 6" 1 Dia.
8' 0" Inside
8" B&B Valve
Preheater & Secondary Dust Catcher
Ruddiman Primary Scrubber
Ruddiman Tower Scrubber and Dryer

FIG. 1. COMBINED HEATER AND SECONDARY DUST CATCHER

connected with the overflow troughs and maintains the water level in the latter lower than that of the water in the tank.

The cooling tower comprises a vertical cylindrical vessel having a conical top with a shaft bearing at the apex, and a conical bottom having a stuffing box at the apex to form a gas chamber having an inlet and an outlet pipe. In lieu of columns the cylinder is extended to the ground level to form a dust-tight inclosure for the operating mechanism.

A vertical shaft is centrally extended from a thrust bearing at the ground level through the gas chamber to a bearing at the top. On the shaft are arranged, at suitable distances, a number of circular perforated baffle plates. Above these, arranged in series, are circular perforated baffle plates fitted with nozzles

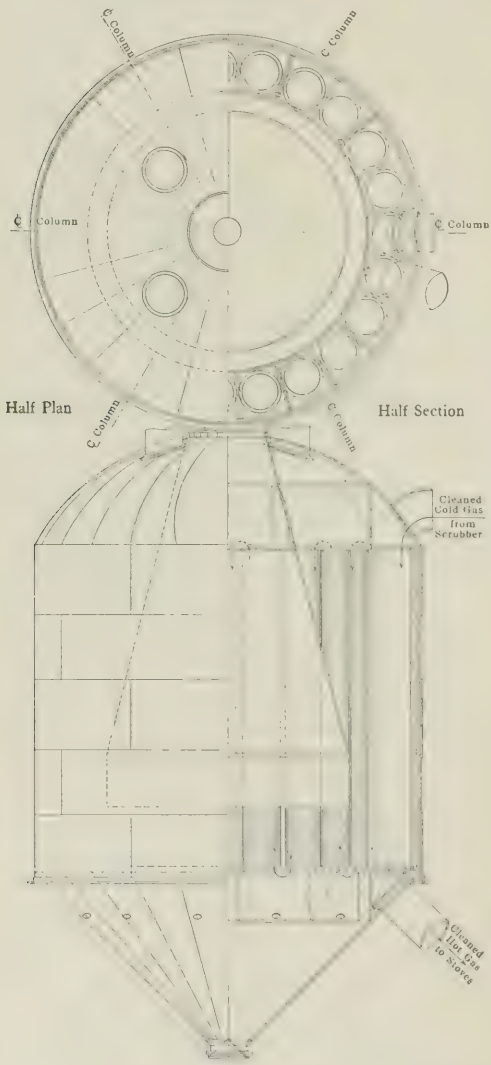

FIG. 2. COMBINED PRIMARY DUST CATCHER AND HEATER

similar to, and arranged on the shaft in the same manner as those in the primary scrubber.

Spray pipes are arranged to produce showers of water between the baffles. A sleeve is attached to the stuffing box casting and encircles the shaft for a suitable distance; slightly above it is an umbrella attached to the shaft, both combining to protect the shaft from dirt collecting at the bottom of the cone.

The scrubber and cooling tower shafts are connected up to take power from the same driver.

In operation the highly heated gas from the dust catcher passes through the flues of the heater at a greatly reduced velocity, its temperature considerably lowered by radiation. Entering the dust chamber over a large area (see arrows) the velocity of the gas is reduced to about 170 ft. per minute (at 400 deg. Fahr.), thereby releasing a high percentage of dust. The twice dry-cleaned gas then passes, via the inverted elbows, to the primary scrubber and the boilers in about the proportion of one-third and two-thirds respectively. The portion of gas passing to the primary scrubber is broken up into a large number of small jets by its passage through the nozzles; a portion of the dust is deposited on the wet surface of the first baffle. Passing through the nozzles of the first baffle the gas jets impinge on the wet blank surfaces of the second baffle, which surfaces are directly opposite the nozzles. The velocity of the gas passing through the nozzles is practically undiminished, since the sum of the areas of the nozzles above the water level is but slightly greater than the area of the inlet pipe. Dust is deposited on each baffle in succession in this way, the process being repeated as many times as desired and being determined by the number of baffle plates used. Spray pipes between the baffles furnish cooling water in finely divided form, thereby further increasing the efficiency of the cleaner by scrubbing and cooling the gases as they pass between the baffles.

The dust deposited upon the baffles is constantly removed by their rotary passage through the water in the tank, so that they constantly present a freshly washed surface for the gas to impinge against and the baffles are kept cool and wet during their transit through the gas chamber (at 20 r.p.m. no part of the baffle is in contact with the gas longer than 1½ sec.). The nozzles have a bucket-like effect in lifting the water into the gas chamber, thus aiding in cleaning and cooling the gas as well as the surfaces of the baffle plates. The water in the tank is constantly agitated by the passage of the baffles therethrough and this prevents the accumulation of floating dirt at the water level which might tend to adhere to the baffle plates and prevent their efficient operation. The scum is carried off with the overflow by drain pipes connected with troughs arranged at the ends and inside the tank at the water level.

The water is admitted to the tank below the water level, and to the gas chamber through pipes connected with a settling tank arranged above the scrubber to receive the waste water from the cooling tower. The supply is thus made to do double duty.

From the scrubber the gas passes to the cooling tower, where it is brought in close contact with successive showers of water between the perforated baffles. Channeling is prevented by the perforations and

the spiral-like motion created by the revolving baffles. Cleaned, cooled but wet, the gas then passes through the series of baffles with nozzles. Its velocity is accelerated in passing through the nozzles, causing the mechanically carried moisture to be deposited on the baffles in like manner performed in the scrubber. The water and dirt deposited on all the baffles will be thrown to the walls of the cylinder by centrifugal force and washed down between the cylinder and the periphery of the baffles to the drain pipe leading to the gas-tight settling tank, whence the water flows to the scrubber for second service.

The cooling tower is self-cleaning. Leaving the cooling tower the clean, dry, cold gas enters the first pass in the heating chamber where it expands and moves slowly down, entering the second pass at the bottom, thence up and down and up through the second, third and fourth passes respectively, gathering in transit the radiated heat from the hot gases passing down through the flues. On reaching the top of the fourth pass it enters the central pipe and gathers more heat from the elbow and pipe in the dust chamber. The clean, dry, hot gas now passes to the brick-lined stove main ready to ignite on reaching the burners.

The pipe connecting the cooling tower and the heater should be insulated to prevent condensation during cold weather.

Fig. 2 of the illustrations shows another method of preheating the cleaned gas, wherein the primary dust catcher and heater are combined in one vessel.

It consists of the usual form of dust catcher, but of ample dimensions to permit a series of large pipes to be circuitously arranged inside the cylinder shell for the passage of the cleaned gas. In lieu of return or U bends to form a continuous passage through the series of pipes, chambers at the upper and lower ends of the pipes are formed by header plates attached to the cylinder shell and to rings attached to the dome and bottom cone, with baffles spaced to connect the pipes for continuous passage. The chambers serve to economize space and to mix the gas currents of different degrees of temperature to produce a uniform temperature at the outlet pipe. The bottom chambers are provided with hand holes for cleaning if necessary.

The passage of gas is shown by the arrows. As the ratio of the gas passing through the dust catcher to that passing through the heating pipes is nearly 5 to 1, the temperature of the cleaned gas will be raised far above its initial temperature, and ignite at the stove burners.

A funnel-shaped extension of the down-comer pipe directs the gas toward the heating pipes. Attached to it is a ring of suitable width to divert the heavier materials, during a slip, from the ring forming the gas chambers arranged around the base of the cone bottom.

Four outlets are provided in the dome to prevent channelling. One will be connected with the scrubber, and three to merge into one pipe leading to the boilers.

As the dust catcher is of large diameter the flow of gas will be very slow, based on 45,000 cu. ft. gas per minute, and at 400 deg. Fahr. T. T. it will be about 220 ft. per minute leaving the funnel, and about 120 ft. per minute for the up-flow. Under these conditions the gas would be much cleaner than that from the usual dust catcher and perhaps sufficiently clean for the boilers. But if further cleaning is desired it would better be run through a Mullen gas washer, since the sensible heat will be retained and the expense of operation is practically nil.

The cylinder shell of the dust catcher has a 4½-in. brick lining.

The size of both types of heaters is based on 45,000 cu. ft. gas per minute, 30,000 cu. ft. for the boilers and 15,000 cu. ft. for the stoves.

229 Front St.,
New York City

A Modified Aluminum Welding Process

A new aluminum solder for which excellent results are claimed has been developed and placed on the market by the Alumunite Manufacturing Co., of 427 Fourth Avenue, New York City. It is intended as a substitute for the electric and acetylene-welding processes. and the undesirable features of many aluminum solders are stated to have been overcome. Lessened cost and simplicity of application are also claimed. Also the absence of high temperatures as alumunite requires only 350 deg. Fahr.

It contains no lead or antimony; the main ingredients being aluminum, tin and zinc, and its tensile strength on lap and butt joints is from 8500 to 12,500 lb. per sq. in. Repairs are stated to remain permanent and not to disintegrate.

American Made Pyrometer Protection Tubes

After a long period of experimentation in the production of porcelain pyrometer protection tubes, Charles Engelhard, 30 Church St., New York, has developed a ware to take the place of the formerly imported Marquardt porcelain. The ware is called Impervite and a description of it is given as follows by the manufacturer:

The body of the two tubes, *i.e.*, Impervite and Marquardt, is practically identical, having almost exactly the same coefficient of expansion, the same mechanical strength, the same porosity, and both absolutely without effect upon platinum wire under high temperatures. The fusing point of the body has not been accurately determined, but it is above 3500 deg. F.

The glaze of the Impervite tube is of a different nature than Marquardt, being harder after it is matured, and having a softening point more than 100 deg. C. above the softening point of the Marquardt glaze. This glaze is thoroughly impervious when uniformly applied, and strongly resistant to fluxing action. It possesses a further decided advantage in that it does not become as sticky at high temperatures above its softening point, as does the Marquardt glaze, as a result of which it does not so readily adhere to an outside protecting tube when heated above the softening point, and then allowed to cool below the softening point.

The body and glaze as used in Impervite tubes, lend themselves to other porcelain ware.

Not only the accuracy, but the life of the thermocouples very much depends upon the ability of the protecting tubes to exclude all gases, and to stand up both physically and mechanically under the furnace conditions in which they are installed.

It is now becoming common practice not only to protect thermo-couples of the platinum-rhodium and platinum-iridium group with this type of tube, but also the thermo-couples known as "base metal" thermo-couples, it having been found that the accuracy and life of base metal thermo-couples, when so protected, are very materially improved.

Book Reviews

Empirical Formulas. By **Theodore R. Running.** Octavo (15 x 22.5 cm.), 146 pages, 52 diagrams. Price, $1.40 net. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited.

This volume is No. 19 of the Mathematical Monographs edited by Mansfield Merriman and Robert S. Woodward. It is intended to assist engineers to find formulas to fit their observations, so as to facilitate engineering calculations and to get exact interpolations. The first five chapters deal with simple tests to be applied to a set of data to determine if they can be represented by certain simple types of equations; another chapter deals with the method of least squares; another with formulas for interpolation; another with approximate formulas for areas, volumes, moments of inertia, etc. The idea throughout is to help the engineer to simple working formulas representing his data, rather than any exact development of formulas representing natural laws. Every experimental and practicing engineer may find help in such a discussion. The treatment is sufficiently elementary to be within the capabilities of anyone who can use the calculus.

* * *

Evaporating, Condensing and Cooling Apparatus. By **E. Hausbrand.** Second English edition, translated from the second revised German edition by A. C. Wright, B.Sc. Octavo (22 x 14 cm.), xxiii+, 401 pages, 21 illustrations. Price $5 (12/6) net. London: Scott, Greenwood & Son.

An engineering compendium covering the quantitative calculation of the constants and efficiency of such apparatus. Although a little ponderous, and going into unnecessarily minute detail at places, yet it is thorough, clear and conscientious. The treatment is on the basic laws of physics, and is largely mathematical. There is a minimum of merely descriptive matter. The only defect is that the translators did not introduce some more recent data on heat transmission, radiation, etc., which has appeared since the German edition was revised, sixteen years ago. Numerous calculated-out examples give relief to the theoretical treatment and render the work very practical and easy to apply. It is a good whetstone for chemical and mechanical engineers to sharpen their wits upon.

* * *

The Principles of Iron Founding. By **Dr. Richard Moldenke.** Octavo (15 x 23 cm.), x + 517 pages, 45 illustrations; price $4.00 net. New York, McGraw-Hill Book Company, Inc.; London, Hill Publishing Company, Ltd.

This is a true compendium of a life-time experience. The author, the genial and indefatigable secretary of the American Foundrymen's Association for many years, is here at his best. He narrates his experiences and systematically courses through his subject matter from planning the foundry to selling its products as if performing a labor of love and without writing a dull or a dry paragraph. Strictly speaking, it is more human and intuitive than accurately scientific, but the latter quality can be left to those other writers who are always accurate and never interesting. By an unfortunate slip, the data given on the thermo-physics of iron on pages 109 to 112, are the B.t.u. per *kilogram* and not per *pound;* they need to be divided by 2.2 to be correct. This is but a small blemish, however, on a very readable and valuable book.

* * *

Analysis of Copper. By **George L. Heath.** 292 pages. Price $3.00. New York: McGraw-Hill Book Company, Inc.

This book very acceptably fills its place among others for use in industrial laboratories. The methods given are those of which industrial practice has fully demonstrated the merit. Unnecessary details have been omitted though sufficient guidance is given in the several schemes.

Exception might be taken to the author's conclusion concerning the reliability of the scheme for arsenic and antimony there given. Any scheme that is accurate must be reliable; and in this particular instance experience has shown that the scheme is as reliable as it is accurate, presuming that the directions given are closely followed. This latter is true of any analytical scheme.

Mention might well have been made of the use of gauze cathodes in the assay of copper by electrolysis. By their use the length of time of deposition is materially shortened and the use of mechanical stirrers is obviated; for by using an increased current in conjunction with the gauze cathode sufficient agitation of the solution is obtained by the more rapid evolution of gas from the electrolyte.

The practical usage of a book of this nature is determined largely by its indexing. In this case the author has done his work well and the various schemes are thus rendered more accessible to the chemist who is following the methods.

Personal

Mr. **Frank Wharton Brooke,** formerly metallurgist of Crowleys, Detroit, and at the Ludlam Steel Works, and Mr. G. W. Ketter, who has just finished the erecting and installation of ten 6-ton furnaces at the British Forgings, Ltd., Toronto, Ont., have joined the staff of the Electric Furnace Construction Co. at Philadelphia.

Mr. **Charles F. Hall,** formerly structural and mechanical engineer of Armour & Co., has joined the staff of the Booth-Hall Co., 565 West Washington Street, Chicago, Ill., manufacturers of electric steel furnaces, in the capacity of production manager.

Mr. **Allen Hoffer,** superintendent of the blast furnaces for Worth Brothers Company, Coatesville, Pa., has resigned, effective Nov. 15, to become associated with the Cliffs Iron Company, Cleveland, Ohio, in the capacity of superintendent.

Mr. **Richard K. Meade,** consulting chemical and industrial engineer, of Baltimore, Md., announces that he has formed a partnership with Mr. Howard C. Tompkins, one of his associates, under the name of

Richard K. Meade & Co. Mr. Tompkins is a graduate of Cornell University (1903) with the degree of civil engineer and has had many years' experience in the design and construction of cement, lime, plaster ad chemical plants; in steel and reinforced concrete work and in general industrial engineering.

Mr. **R. J. Morgan,** formerly with the Midvale Steel and Ordnance Company, has been appointed supervisor of sales of the American Steel Export Company, New York. Mr. Morgan prior to his connections with the Midvale Steel & Ordnance Company, spent thirteen years with the Carnegie Steel Company.

Prof. **Horace B. Patton,** who served a period of twenty-four years as professor of geology and mineralogy at the Colorado School of Mines, announces that he has opened an office at Golden, Col., for the practice of his profession as consulting and field geologist. Special attention will be paid to oil and gas and to metalliferous deposits.

Mr. **W. O. Renkin,** who for some years past has been chief engineer with the A. M. Byers Company of Pittsburgh, has resigned from that company to act in the capacity of manager of the engineering department of the Quigley Furnace Specialties Company, 26 Cortlandt Street, New York, N. Y., who specialize in powdered coal installations. Previous to going with the A. M. Byers Company Mr. Renwin spent some years as resident engineer in charge of the organization and construction of the works and town of Sakchi, Bengal, India, for the Tata Iron & Steel Company.

Of the members of the instructing staff of the department of chemistry at the Massachusetts Institute of Technology, Professors **W. H. Walker** and **J. F. Norris,** Dr. **F. H. Smyth** and Mr. **R. E. Wilson** are on leave of absence, and Prof. **W. K. Lewis** devotes only part of his time to the institute during the present year. All these men are actively engaged on gas-defense problems, and are holding responsible positions in the organization which is dealing with these problems at Washington and elsewhere. Prof. **A. A. Noyes** spends a part of his time at Washington, in connection with the work of the National Research Council and the Nitrate Committee. Professors **Mulliken, Spear** and **Mueller** have also been engaged at the institute on investigations relating to gas-defense. Professors **F. J. Moore** and **H. P. Talbot** gave, during a portion of the summer courses of instruction to students who were expecting to apply for commissions in the Reserve Officers' Training Corps.

CURRENT MARKET REPORTS

The Iron and Steel Market

A third batch of set prices was announced at Washington, Nov. 5, practically completing the price fixing for the iron and steel producing industry. Summarizing, the set prices, with the dates of announcement, are as follows:

Sept. 24: Lake Superior iron ore, the 1917 schedule, subject to readjustment in the event of the Lake rate departing from $1, making Mesabi non-Bessemer at Lake Erie dock $5.05; pig iron, $33 for basic and foundry; bars, 2.90c.; shapes, 3c.; plates, 3.25c.

Oct. 11: Billets, 4 x 4 and larger, $47.50; small billets, $51; slabs, $50; wire rods, $57; grooved skelp, 2.90c.; universal, 3.15c.; sheared, 3.25c.; shell steel rounds gothic billets, etc., 3 to 5-in., 3.25c.; up 5-in., 3.50c.; to 10-in., 3.75c.; over 10-in., 4c.

Nov. 5: Sheets, black, 28 gage, 5c.; blue annealed, 10 gage, 4.25c.; galvanized, 28 gage, 6.25c.; tin plate, $7.25 for 100-lb. cokes; pipe, 51 per cent card basing discount, equal to 52, 5 and 2½ off list on ¾ to 3-in.; plain wire, 3.25c.

With the co-operation of the American Iron and Steel Institute, using committees of substantially the same personnel as resigned as subsidiary to the Advisory Commission on account of the menace of the Pomerene amendment to the Lever act, details, differentials, etc., are being worked out. Pig iron is set at $33 f.o.b. furnace, all districts, for No. 2 foundry and basic, malleable at $33.50, Bessemer at $36.30, low phosphorus, copper-bearing, $50; no copper, $53. No. 2 foundry is 1.75 to 2.25 per cent silicon.

Billets, sheet bars and slabs are f.o.b. Pittsburgh or Youngstown. Rods, shell steel and skelp are f.o.b. Pittsburgh, and wire, sheets, tin plates and pipe will probably be the same. Merchant bars, shapes and plates are f.o.b. Pittsburgh or Chicago, this being quite an innovation.

The furnace-coke price was set at $6 by President Wilson, the price being announced Sept. 24. This was under authority of the Lever act, despite the quibble of a few coke operators to the contrary.

All the prices are on the principle of "one price for all," the Government, its Allies, and the general public. This means that the producers make such sales of war material as the Government desires them to make, while as to the public they sell at will; but if they sell, at not above the set prices.

Producers are carrying out the agreement, for it is an agreement, except in the case of coke, in spirit as well as in letter. They do not sell to the public when they cannot make the deliveries desired, and in the main they are indisposed to make sales for far forward delivery, using as one reason the proviso of the Government that the set prices are subject to revision Jan. 1 or later. Producers are endeavoring, as usual, to take care of regular customers, and are as a rule, indisposed to sell to chance buyers not regular customers, one reason being that the inquirer may have a contract with another producer at a price higher than the set price.

In the case of pig iron there has been a broader market, with more activity than for weeks preceding the price setting. For instance, Messrs. W. P. Snyder & Company have for years compiled monthly a Bessemer and a basic pig-iron average, weighted according to tonnages 1000 tons and over, of all valley iron sold. The computation for October shows precisely the set prices, $36.30 for Bessemer and $33 for basic, and the tonnage entering the computations was fully 100,000 tons, or more than in any of the three months preceding. This showing indicates a willingness on the part of producers to transact business, and does not indicate that pig iron is not scarce, for it is as scarce, physically, as it was. There is not enough pig iron to operate all the steel-making facilities at capacity, capacity being estimated at 49,000,000 tons of ingots, with 5,000,000 tons under construction, and production 44,000,000 tons.

In unfinished steel the market movement is very light, there being merely occasional sales of odd lots arising in course of mill operation.

In finished steel products there is a light movement, but there is more or less trading in all commodities.

OPEN MARKET AND SET MARKET

The transition from an open market into the set market occurred quite differently in the various products. In bars, shapes and plates a great drop was represented in the act of price setting, particularly as the open market existing had been made upon relatively early deliveries at what would be "premiums" if there had been a well-defined market for late deliveries, which was not the case. In billets, which had reached $95 to $100 in June, there was a very narrow market for a few weeks preceding the price fixing, with occasional offerings at lower and lower prices down to $60. In wire there had been the anomaly of the American Steel & Wire Company adhering to its prices first made last March, based on $3.20 for nails, while the independents had advanced to $3.40 and then to $4. Just prior to the price announcement the American company had advanced its prices from 3.15c. to 3.25c. on plain wire and from $3.20 to $3.50 on nails. The National Tube Company and Republic Iron & Steel Company occupied the unique position that with respect to pipe their official prices were below those set by the Government. They were adhering to their 55 per cent list of April 2, allotting their tonnage to regular customers while other mills had advanced May 1 to a 49 per cent list, and La Belle, Wheeling Steel & Iron, and Jones & Laughlin had advanced under date of June 25 to a 42 per cent list, and one that carried advances generally of 10 to 15 points on sizes other than base. Thus the 51 per cent prescribed list represented an advance for two producers and declines for others. The set price is regarded as too low for detached mills, if they must pay the set prices for skelp, and skelp mills may make concessions to regular customers.

Except for plates, sheets had scored the greatest advance, reaching 8c. to 9c. in June, and holding that level fairly well until early in October. Then a decline began, developing into a break. The set prices were given to the newspapers on the evening of Nov. 5, becoming known to the trade the next morning. A week before some sheets were available at 5.50c., if not at 5.25c., while on Nov. 5 there were some exceptional offerings of black sheets at 5c., the price just to be announced. The sheet mills had driven the situation too hard a few months earlier, and some of them were almost bare of orders.

PRODUCTION AND CONSUMPTION

Based on a 44,000,000-ton ingot rate, finished rolled steel is being produced at the rate of about 33,000,000 tons. Last year's production was 30,500,000 tons, direct and indirect exports leaving close to 24,000,000 tons for purely domestic consumption. The total war requirements are variously estimated at 10,000,000 to 15,000,000 tons, the uncertainty being not as to what it would be well to consume, but as to the fabricating or manufacturing capacity that can be marshaled to convert steel mills products into ships, munitions, etc., and as to the rolling capacity for certain products, particularly plates. Presumably there will be practically no exports to neutrals unless all other requirements are satisfied. There may be left for ordinary domestic consumption almost as much steel as was absorbed in 1916, while it is a question, at any rate unless the railroads can become liberal buyers, whether so much steel can be absorbed in a commercial way when the country is at war. The desire to consume may be reduced, and likewise the ability to consume, through labor shortage, lack of adequate transportation facilities, and shortage of certain descriptions of rolled steel, as well as other raw materials.

Non-Ferrous Metal Market

Friday, Nov. 9.—The markets have been quiet. Copper is unchanged at the price fixed by the Government. Tin is scarce and considerably higher. Lead has advanced and the market appears strong. Spelter is weak and lower. Antimony has also declined. Silver is slightly higher.

Copper.—The general prevailing belief that sales of copper should not be made at higher than 23.50 cents is stopping considerable business and causing considerable copper to be held which might be offered for resale and which in some quarters is badly needed. Holders cannot afford to sell at 23.50 cents copper which they purchased at a higher price.

Tin.—Straits tin is nominally quoted at 70.00 cents spot. Some Banca tin and English Lamb & Flagg has been offered at 66.50. There is a considerable shortage of tin in this country, and while the statistics show no real shortage throughout the world, the stocks in this country are low owing to the stringent shipping situation.

Lead.—Lead was advanced on Nov. 7 by the trust from 6.00 to 6.25 cents. Good business is reported lately from both Government and private interests and the market is strong. Independents are asking 6.25-6.50 spot. Futures up to December are no lower.

Spelter.—Little interest has been shown and the market is week. Prompt spelter is quoted at 7.67½ New York and up to 7.80 for futures. The Government will require enormous quantities of high-grade spelter for shells, estimated at 100,000,000 lb. per year, and this quantity is liable to increase. The price on this material may be fixed by the Government.

OTHER METALS

Antimony, Chinese and Japanese, pound	0.13¾—0.14
Aluminium, No. 1 Virgin, 98-99 per cent, pound	0.36 —0.38
Magnesium, metallic, pound	2.00 —2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask, California	100.00
Silver, ounce	.86⅛
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

Chemical Market

Coal Tar Products.—The general position of these markets shows somewhat of an improvement over the past few weeks. Phenol, toluol and naphthaline look particularly strong, and difficulty is generally experienced in locating real offers.

Benzol.—No material improvement in this market is noted and supplies exceed the demand owing to the fact that the export movement is more or less suspended.

Beta Naphthol.—A fairly steady demand is noted for small and moderate quantities and it is thought probable that a general demand for large lots would result in a material advance in this market. There are, however, only a limited number of producers in this field.

Aniline Oil.—This product is one which requires a license for export, and in consequence does not show any marked improvement. Stocks are rather large in some quarters and the situation is rather disappointing from a manufacturing viewpoint.

Benzoate of Soda.—A very firm situation exists and the demand for this product exceeds the supply.

Toluol.—The general demand has improved considerably, but supplies continue scarce, however. the greater part of the production is going into the manufacture of explosives.

Naphthalene.—A rather firm market continues to prevail, stocks, however, are light and difficult to obtain while manufacturers are not inclined to quote for future delivery.

Phenol.—This production has been well sold up over the first half of the coming year, and it is noted that the market is becoming exceedingly strong due to the difficulty in securing the material.

Dinitrophenol.—A better request for this product has been noted for a while past, and prices asked seem to be firmer.

Metanitranilene.—This product is being made by a few manufacturers, and at present spot supplies do not appear to be available.

Monochlorbenzol.—Supplies of this material seem to be quite ample; however, there does not appear to be much movement into consuming channels.

Heavy Chemicals.—There is an extreme quietness noted in the chemical market and somewhat of a reduction in all products which come under this heading is noticeable. These conditions are no doubt attributable to the difficulties experienced in securing permits for export.

Caustic Soda.—This market was practically neglected but during the past few days a rather persistent inquiry occurred. This resulted in the forming of prices, and buyers found very little real material offered. As 1918 approaches, the price is growing firmer and the firms in a position to quote are holding to high prices.

Soda Ash.—There has been a pronounced flurry in soda ash during the two weeks under review and the market has been subject to material recovery. Offers of real material are much restricted, particularly shipment from the works, which are not selling at a very high figure.

Bleaching Powder.—Bleach continues neglected and prices seem to be at a low level. No transactions of any importance have been noted for some time past.

Cyanides.—The position of this market has firmed up somewhat over the past week, although stocks are quite scarce and but little are available.

Bichromate of Soda.—Prices named for this product are at rather a low level, and tendency to decline is noted.

Bichromate of Potash.—Very little change is noted in the past few weeks, and, if anything, prices are not quite as firm.

Saccharine.—A decidedly upward turn is noted in this market, and considerable material is said to have changed hands for export.

Chlorates.—There is very little change noted in this situation either in the potash or soda, and prices range about the same.

Copper Sulphate.—A very firm and steady market is noted and most producers are quoting at the higher level.

Acids.—The acid situation continues stronger than ever, and prices for all grades have advanced particularly for nitric, muriatic and sulphuric acids. Oleum is very scarce, and at present difficult to obtain. The present high freight rates and cost of laid-down sulphur ore brings the cost of pyrites almost up to the value of brimstone acid. In consequence of this there is very little difference between brimstone and pyrites prices at the present time.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 8, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.36 —	.37
Acid, acetic, 28 per cent	lb.	.06 —	.06½
Acetic, 56 per cent	lb.	.11¼ —	.12½
Acetic, glacial, 99½ per cent, carboys	lb.	.36½ —	.37
Boric, crystals	lb.	.13 —	.13¾
Citric, crystals	lb.	.71 —	.72
Hydrochloric, C.P	lb.	.08 —	.08¼
Hydrochloric, 20 deg	lb.	.02½ —	.02⅝
Hydrochloric, C.P., conc., 22 deg	lb.	.02¾ —	.02⅞
Hydrofluoric, 30 per cent, in barrels	lb.	.06¼ —	.06½
Lactic, 44 per cent	lb.	.15½ —	.16½
Lactic, 22 per cent	lb.	.06¼ —	.06½
Nitric 36 deg	lb.	.07¼ —	.07⅝
Nitric, 42 deg	lb.	.09¼ —	.10
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 47 per cent-50 per cent	lb.	.07½ —	...
Picric	lb.	.75 —	.85
Pyrogallic, resublimed	lb.	3.00 —	3.10
Sulphuric, 60 deg	ton	25.00 —	30.00
Sulphuric, 66 deg	ton	36.00 —	40.00
Sulphuric, oleum (Fuming), tank cars	ton	50.00 —	55.00
Tannic, U. S. P., bulk	lb.	1.25 —	...
Tartaric, crystals	lb.	.77 —	.79
Tungstic, per lb. of W	lb.	1.80 —	1.90
Alcohol, sugar cane, 188 proof	gal.	5.20 —	5.40
Alcohol, wood, 95 per cent	gal.	1.20 —	1.22
Alcohol, denatured, 180 proof	gal.	.84 —	.86
Alum, ammonia lump	lb.	.04 —	.04¼
Alum, chrome ammonium	lb.	.18 —	.19
Alum, chrome potassium	lb.	.24 —	.25
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08¾ —	.09
Aluminium sulphate, technical	lb.	.02½ —	.03¼
Aluminium sulphate, iron free	lb.	.03½ —	.04
Ammonia aqua, 26 deg. carboys	lb.	.16½ —	.17
Ammonium carbonate	lb.	.11½ —	.12½
Ammonium nitrate	lb.	.20 —	.22
Ammonium, sulphate domestic	lb.	.07⅛ —	7.15
Amyl acetate	gal.	5.25 —	5.40
Arsenic, white	lb.	.16 —	.16½
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	70.00 —	...
Barium carbonate 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	70.00 —	80.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½ —	.05
Barium nitrate	lb.	.08½ —	.11½
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼ —	.01½
Borax, crystals, sacks	lb.	.07½ —	.07¾
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.65 —	.70
Calcium, acetate, crude	lb.	.06 —	.06⅛
Calcium, carbide	lb.	.08½ —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	... —	...
Carbon bisulphide	lb.	.07 —	.07½
Carbon tetrachloride, drums	lb.	.16 —	.16½
Caustic potash, 88-92 per cent	lb.	.82½ —	.85
Caustic soda, 76 per cent	lb.	.08¼ —	.08¼
Chlorz, liquid	lb.	.15 —	.18
Cobalt oxide	lb.	1.40 —	1.50
Copperas	lb.	.01¼ —	.01½
Copper carbonate	lb.	.30 —	...
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.0965—	.0975
Cream of tartar, crystals	lb.	.55 —	.60
Epsom salt, bags	lb.	.03¼ —	.04
Formaldehyde, 40 per cent	lb.	.17½ —	.18
Glauber's salt	100 lb.	.80 —	...
Glycerine, bulk, C. P	lb.	.70 —	.71
Iodine, resublimed	lb.	3.50 —	3.55
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17½—	.19
Lead arsenate	lb.	.16 —	.19
Lead nitrate	lb.	.17½—	.18
Litharge, American	lb.	.09½—	.11½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.48 —	.55
Magnesium carbonate, tech	lb.	.10 —	.11
Nickel salt, single	lb.	.14½—	...
Nickel salt, double	lb.	.11½—	...
Phosphorus, red	lb.	1.00 —	...
Phosphorus, yellow	lb.	2.10 —	2.15

Potassium bichromate	lb.	45½	—	46
Potassium bromide granular	lb.	1 35	—	1.40
Potassium carbonate calcined, 85-90 per cent	lb.	75	—	.
Potassium chlorate, crystals	lb.	43	—	.45
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	350 00	—	375 00
Potassium nitrate	lb.	28	—	.30
Potassium permanganate	lb.	3 85	—	3.90
Potassium prussiate, red	lb.	2 70	—	2.80
Potassium prussiate, yellow	lb.	1 27	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	400 00	—	.
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	10½	—	.11½
Salammoniac, white gran	lb.	.16	—	.16½
Sal soda	100 lb.	1.25	—	1.50
Salt cake	100 lb.	1.25	—	1.50
Silver cyanide, based on market price of silver	oz.	.	—	.
Silver nitrate	oz.	.57	—	.59
Soda ash, 58 per cent. light, flat	100 lb.	3.05	—	3.10
Soda ash, 58 per cent, dense, flat	100 lb.	4.00	—	.
Sodium acetate	lb.	13¼	—	.13½
Sodium benzoate	lb.	2.15	—	2.25
Sodium bicarbonate, domestic	lb.	02⅝	—	02¾
Sodium bicarbonate, English	lb.	.	—	.
Sodium bichromate	lb.	18¼	—	18½
Sodium bisulphite, powd	lb.	05½	—	.06½
Sodium chlorate	lb.	.23	—	.25
Sodium cyanide	lb.	.48	—	.51
Sodium fluoride, commercial	lb.	18½	—	.
Sodium hyposulphite	lb.	01¾	—	.02
Sodium nitrate, 95%	100 lb.	4 65	—	4.75
Sodium nitrite	lb.	.32	—	.35
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate	lb.	.04	—	.04½
Sodium prussiate, yellow	lb.	.35	—	.36
Sodium silicate, liquid	100 lb.	1.80	—	2.00
Sodium sulphide, 30 per cent crystals	lb.	02½	—	.03½
Sodium sulphide, 60 per cent, fused	lb.	03¾	—	.04½
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4 05	—	4.10
Sulphur, roll	100 lb.	3 70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	19¼	—	19½
Tin oxide	lb.	64½	—	.65
Zinc carbonate	lb.	.35	—	.38
Zinc chloride	lb.	10¾	—	10¾
Zinc cyanide	lb.	.50	—	.
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	14½	—	.15
Zinc sulphate	lb.	05½	—	05¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.45	—	.46
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	2 00	—	.
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.15	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1 10	—	.
Alpha naphthol, distilled	lb.	1 60	—	.
Alpha naphthylamin	lb.	.60	—	.65
Aniline oil, drums extra	lb.	25½	—	.26
Aniline salts	lb.	31½	—	.33
Anthracene, 80 per cent	lb.	.10	—	.
Benzaldehyde	lb.	4 00	—	4 50
Benzidine, base	lb.	1 80	—	1 85
Benzidine, sulphate	lb.	1 40	—	1.50
Benzoic acid	lb.	2 50	—	.
Benzyl chloride	lb.	1 75	—	2 00
Beta naphthol benzoate	lb.	7.00	—	8 00
Beta naphthol, sublimed	lb.	87½	—	.90
Beta naphthylamin com	lb.	2 50	—	.
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3 75	—	4 25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.42	—	.44
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.62
Dimethylaniline	lb.	.60	—	.65
Diphenylamine	lb.	1 00	—	.
H-acid	lb.	3 00	—	3.50
Metaphenylenediamine	lb.	1 75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09⅝	—	.10
Naphthalene, balls	lb.	.10	—	.11
Naphthionic acid, crude	lb.	1 50	—	1.75
Naphthylamin-disulfonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	.	—	.
Ortho-toluidine	lb.	.90	—	1 00
Orth nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	1 50	—	5.00
Para-amidophenol, H. Cl	lb.	5 25	—	5.75
Paranitraniline	lb.	1 10	—	.
Para-nitro toluol	lb.	1 50	—	1 60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2 25	—	.
Phenol, U. S. P	lb.	.52	—	.53
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.00	—	13.50
Salicylic acid	lb.	1.35	—	1.38
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	2.50	—	.
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	.
Corning, Ohio	bbl.	2.60	—	.
Somerset, Ky	bbl.	2.40	—	.
Wooster, Ohio	bbl.	2.38	—	.
Indiana	bbl.	1.98	—	.
Illinois	bbl.	2.12	—	.
Oklahoma and Kansas	bbl.	2.00	—	.
Caddo, La., light	bbl.	2.00	—	.
Corsicana, Tex., light	bbl.	2.00	—	.
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	.

Fuel Oil

New York	gal.	.10½	—	.
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	.70	—	1.55
Texas	bbl.	1.60	—	.
Los Angeles	bbl.	1.45	—	.
San Francisco	bbl.	1.45	—	.

Gasoline (Wholesale)

New York	gal.	.24	—	.
Boston	gal.	.25	—	.
Pittsburgh	gal.	.24	—	.
Chicago	gal.	.21	—	.
Oklahoma	gal.	.23	—	.
San Francisco	gal.	.20	—	.

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	.
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—	.
Pine oil, destructively distilled	gal.	.43	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—	.
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	.
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	.
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	.
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.32	—	.
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	.
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—	.
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—	.
Wood creosote, ref. f.o.b. Florida	gal.	.30½	—	.

Vegetable and Other Oils

China wood oil	lb.	.22	—	.23
Cottonseed oil, crude	gal.	1.30	—	.
Linseed oil, raw, cars	gal.	1.13	—	1.16
Peanut oil, crude	gal.	1.38	—	.
Rosin oil, first run	gal.	.35	—	.
Rosin oil, fourth run	gal.	.66	—	.
Soya bean oil, Manchuria	lb.	16½	—	.17
Turpentine, spirits	gal.	.54	—	.

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Carnauba wax, flor	lb.	.62	—	.
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.	—	.
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb	bbl.	6.85	—	.
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	18.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	.
Ferrochromium, per lb. of Cr	lb.	.35	—	.40
Ferromanganese, domestic, delivered	ton	275.00	—	.
Ferromanganese, English	ton	325.00	—	.
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	230.00	—	260.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200 00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.40	—	2.60
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Antimony ore, per unit		1.60	—	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.20
Manganese ore, chemical	ton			$100.00
Molybdenite, per lb. of MoS_2	lb.			2.20
Tungsten, Scheelite, per unit of WO_3	ton	26.00	—	27.50
Tungsten, Wolframite, per unit of WO_3	ton	25.00	—	26.00
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium Pentoxide, 99%	lb.			10.50
Pyrites, foreign	unit	.16	—	.16½
Pyrites, domestic	unit	.11	—	.12

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The AERO PHOTOGRAPHY COMPANY, New York. Capital, $25,000. To manufacture cameras and photographic supplies for use on airplanes. Incorporators are: R. J. Pomeroy, R. R. Appleby and W. P. Hammond, 52 Broadway.

The ALLENTOWN MOTOR COMPANY, Wilmington, Del. Capital, $100,000. To manufacture automobiles and motors. Incorporators: Franklin L., M. E. and L. F. Mettler, Wilmington.

The ALUMINUM SOLDER MANUFACTURING COMPANY, New Castle, Pa. Capital, $25,000. To manufacture aluminum solder. Incorporators: Frank E. Alborn, Andrew Knittel and J. V. Cunningham, New Castle.

The AMALGAMATED ANILINE DYE COMPANY, New York. Nominal capital, $5,000. To manufacture chemicals, dyes and kindred products. Incorporators are: Lawrence A. Sherwood, Alfred Jaretzki, Jr., and Stoddard M. Stevens, Jr., 627 West One Hundred and Fifteenth Street, New York.

The AMERICAN AIRCRAFT COMPANY, Dover, Del. Capital, $500,000. To manufacture aeroplanes and other aircraft. Incorporators: M. M. Clancy, C. M. Egner and C. L. Rimlinger, Wilmington.

The AMERICAN AIR CRAFT ARMS COMPANY, Dover, Del. Capital, $500,000. To manufacture firearms for use on aircraft.

The AMERICAN-CANADIAN RESOURCES COMPANY, Dover, Del. Capital, $2,000,000. To manufacture engines and machinery of various kinds. Incorporators are: George G. Stiegler, William F. O'Keefe and M. Gerrman, Wilmington.

The AMERICAN PUTTY & PAINT COMPANY, Jersey City, N. J. Capital, $125,000. To manufacture putty, paints and kindred products. Incorporators: H. and R. R. Max and Morris Alexander, Jersey City.

The AMERICAN ROLLING MILL COMPANY, Cincinnati, Ohio. Incorporated under Illinois laws. Capital, $21,000,000. To operate steel and rolling mills.

The APEX PULVERIZING MILLS COMPANY, Brooklyn, N. Y. Capital, $10,000. Incorporators are: A. T. and C. A. Beach and H. F. Kleinfeldt, 220 Broadway.

The ARCO CHEMICAL COMPANY, New York. Nominal capital, $5,000. To manufacture chemicals and allied products. Incorporators are: J. N. and E. Goetshoff and A. Radtzky, 982 Prospect Avenue, Brooklyn.

The ATLAS WELDING COMPANY, Elizabeth, N. J. Capital, $50,000. To manufacture a patented cutting and welding torch. Incorporators are: John Grouss, Clarence E. Pryor, Walter W. von Todenwarth, Elizabeth, and Charles Ackerman, Brooklyn, N. Y.

The BITUMO ENAMEL COMPANY, Gloucester City, N. J. Capital, $100,000. To manufacture bitumo enamel. Incorporators: Elmer J. Shinn, Hugh V. Ramsay and Frank Breckenridge, Gloucester City.

The BLACK ROCK IRON MINING COMPANY, Johnston, Pa. Capital, $20,000. To engage in a general iron mining business. Incorporators are: Frederick K. Sheesley, Johnston; William A. Perry, Pittsburgh; Edward G. Lewis, E. E. Cramer and Charles Munson, Dover, Del.

The BUSHWICK CORK COMPANY, Brooklyn, N. Y. Nominal capital, $5,000. To manufacture cork. Incorporators: N. Verdier and W. F. Betts, 1105 Nostrand Avenue.

The COLOR SERVICE CORPORATION, INC., New York. Capital, $50,000. To manufacture chemicals, dyes and kindred products. Incorporators: G. Gibbon, H. L. Schaefer and J. T. Fenlon, 55 Liberty Street.

The CONNECTICUT BRASS & MANUFACTURING COMPANY, Wilmington, Del. Capital, $4,000,000. To manufacture brass goods of various kinds. Incorporators: M. M. Clancy, Wilmington, and C. M. Egner, Elkton, Md.

The CONTINENTAL CONSTRUCTION CORPORATION, Dover, Del. Capital, $100,000. To manufacture railway supplies of various kinds.

The DEVOGEL MACHINE & WELDING COMPANY, Paterson, N. J. Capital, $25,000. To manufacture tools and machinery. Incorporators are: John, Richard and L. DeVogel, Paterson.

The EUGENE DIETZGEN COMPANY, Dover, Del. Capital, $3,500,000. To manufacture supplies for draftsmen, artists, etc.

The ECONOMY ELECTRIC COMPANY, Norfolk, Va. Capital, $50,000. To manufacture electrical supplies. Incorporators: E. R. and Charles A. Page, Norfolk.

The EDEL LABORATORIES, INC., Newark, N. J. Capital, $50,000. To operate chemical laboratories. Incorporators are: Milton E. Crawley, Edward H. Schwartz and Homer D. Smith, Newark.

The JOSEPH ELIAS COMPANY, INC., Borough of Queens, N. Y. Capital, $300,000 To manufacture glass specialties. Incorporators are: John G. Griffin, Norman S. Goetz and T. Joffe, New York.

The EMPIRE ELECTRIC STEEL CORPORATION, New York. Capital, $500,000. Incorporators are: Eric Pusinelli, George R. Hamilton and E. H. Rapp, New York.

The FAILING-EASTABROOKS COMPANY, INC., Albany, N. Y. Capital, $5,000. To manufacture chemicals, etc. Incorporators are: Frank D. Estabrooks, John P. Failing and E. H. Vandura, Albany.

The FARBEN-FABRIKEN OF ELBERFELD COMPANY, New York. Capital, $100,000. To manufacture dyestuffs and kindred products. Incorporators are: G. A. Reiss, W. F. and T. M. McDermott, 15 Dey Street, New York.

The FARMERS MACHINE & CHEMICAL COMPANY, Rochester, N. Y. Capital, $100,000. To manufacture machinery and chemicals. Incorporators: J. W. Marshall, W. S. McKinney and S. G. H. Covell, Rochester.

The FEINDEL & PASQUIER CHOMICAL CORPORATION, New York. Capital, $10,000. To manufacture chemicals, etc. Incorporators are: E. E. Feindel and M. Pasquier, 431 West Twenty-fourth Street, New York.

The FIDELITY TIRE & RUBBER COMPANY, Jersey City, N. J. Capital, $5,000. To manufacture rubber tires and kindred specialties. Incorporators: Richard Kramer, Clason Point, L. I.; James L. Meltzer and F. O. Sheehan, New York.

M. GOTTESMAN & COMPANY, INC., New York. Capital, $650,000. To operate pulp, paper and jute mills. Incorporators: S. Schwartzman, M. Brenner and E. M. Souza, 111 Broadway.

The GRANT HAMMOND ARMS CORPORATION, New York. Capital, $1,000,000. To manufacture firearms. Incorporators: S. B. Howard, George V. Reilly, and Arthur W. Britton, 65 Cedar Street, New York.

The HEDD CHEMICAL COMPANY, Hoboken, N. J. Capital $15,000. To manufacture chemicals and kindred products. Incorporators: William S. Driesen, Milton Hart, and Harry Ruff, Chicago, Ill.

The HERCULES STORAGE BATTERY COMPANY, West New York, N. J. Capital, $20,000 To manufacture storage batteries. Incorporators are: A. J. Wiencke, A. J. Ellis, and M. Wiencke, all of North Bergen.

The HIGLO SPECIALTY COMPANY, Dover, Del. Capital, $100,000. To manufacture specialties made of iron, brass, etc.

CHARLES H. HUISKING, INC., New York. Capital, $300,000. To manufacture chemicals and kindred products. Incorporators are: G. P., C. F., and C. L. Huisking, 145 Lincoln Road, Brooklyn, N. Y.

The IMPERIAL TIRE & RUBBER COMPANY, Philadelphia, Pa. Capital, $200,000. To manufacture rubber goods. Incorporators are: I. S. Shubert, F. Nelson and V. T. Casson all of Philadelphia.

The IMPROVED RUBBER COMPANY, INC., Bayonne, N. J. Capital, $100,000 To manufacture rubber products of various kinds. Incorporators: A. A. de Bonneville, Bayonne; E. M. Snell, New York, and Alfred S. Perry, Fairfield, Conn.

The INDEPENDENT MANUFACTURING COMPANY, Carlstadt, N. J. Capital, $20,000. To manufacture paper, chemicals oils, etc Incorporators are: John T. Mulhall, H. Beam, and J. M. Beam, Jersey City.

The INTERNATIONAL DYMALKON PROCESS CORPORATION, New York. Capital, $500,000. To manufacture silicon and aluminum, and engage in a general foundry and machine business. Incorporators: J. A. Poulin, E. O. Anderson, and P. A. Stilwell, 38 Fort Washington Avenue, New York.

The J. B. D. RUBBER COMPANY, Arlington, N. J. Capital, $50,000. To manufacture rubber goods, chemicals, etc. Incorporators: B. A. Dave, Alfred G. Berg, and James H. Robertson, all of Arlington.

The E. J. KERNS MANUFACTURING COMPANY, Newark, N. J. Capital, $50,000. To manufacture aeroplanes. Incorporators are: Edward J. and Francis J. Kerns, and James F. Kelly, Newark.

The KINGS COUNTY IRON & FOUNDRY COMPANY, Brooklyn, N. Y. Capital, $200,000. Incorporators are: C. S. Woodman, T. E. Hodgskin, and J. Friedman, 20 Nassau Street, New York.

KUTTROFF, PICKHARDT & COMPANY, New York. Capital, $200,000. To manufacture chemicals, dyes, and kindred products. Incorporators are: C. Pickhardt and A. and F. Kutroff, 128 Duane Street.

The LEIGHTON-MCMULLIN COMPANY, INC., Philadelphia, Pa. Capital, $50,000. To manufacture paints, etc. William C. McMullin, treasurer.

The LIBERTY CARBON COMPANY, Maytown, Ky. Capital, $100,000. To manufacture carbon black. Incorporators are: W. R. Fowkes, J. A. Wetherell, and S. J. McConnell, all of Clarksburg, W. Va.

The MINERVA LABORATORIES, INC., Chicago, Ill. Capital, $30,000. To manufacture chemicals and allied products. Incorporators: William H. Schlezer, Carl W. Winkler, and G. Van Schanck, all of Chicago.

The MOUNTAIN PAPER COMPANY, New York. Nominal capital, $5,000. To manufacture paper. Incorporators are: C. S. Hunter, L. Lowenstein, and P. Bernstein, 220 Audubon Avenue, New York.

The MOUNT JOY MAGNESIA COMPANY, Mount Joy, Pa. Capital, $150,000. Principal incorporator: O. G. Longnecker.

The NEMA CHEMICAL LABORATORY, New York. Capital, $100,000. To manufacture chemicals and kindred products. Incorporators: L. Scelfo, C. S. Streva, and E. Sivelli, 165 Broadway, New York.

The NIASCO CHEMICAL COMPANY, Hoboken, N. J. Capital, $250,000. To manufacture chemicals. Incorporators: H. J. Camby, R. E. Hetzel, and P. Frankenhoff, Hoboken.

The OXFORD FOUNDRY & MACHINE COMPANY, Oxford, N. J. Capital, $50,000. To manufacture iron and steel products. Incorporators are: William A. Bartley, Oxford; Howard L. Coas, West Orange, and Bernard Brady, Lake Hopatcong, N. J.

The OXY CHEMICAL COMPANY, Niagara Falls, N. Y. Capital, $10,000. To manufacture chemicals and kindred products. Incorporators: Leon W. Gibson, Rollin A. Chardavoyne, and A. B. Smith, Niagara Falls.

The PAQUET WINDOW GLASS MACHINE COMPANY, Jeannette, Pa. Capital, $10,000. To manufacture machinery for producing window glass. Robert Hordis, treasurer.

The PATENT VULCANITE ROOFING COMPANY, Dover, Del. Capital, $5,000,000. To manufacture patent roofing material.

The PERRAULT PAPER PRODUCTS COMPANY, Dover, Del. Capital, $40,000. To manufacture paper products. Incorporators: Jesse H. Perrault, Albert H. Schnoor, and William H. Marcus.

The PHENOL CHEMICAL COMPANY, Chicago, Ill. Capital, $2,500. To manufacture chemicals. Incorporators are: L. C. Barron, William A. Bither, and E. W. Weiss, all of Chicago.

The PIGMENT PRODUCT CORPORATION, New York. Capital, $25,000. To manufacture chemicals, colors, etc. Incorporators: A. Blackburne, J. M. Herzberg, and W. L. Tucker, 141 Broadway, New York.

The POCAHONTAS GRAPHITE COMPANY, Cullman, Ala. Capital, $200,000. To manufacture graphite, iron and steel products. Incorporators: W. L. Shumate, Jr., H. E. McCormack, A. P. Smith, and George H. Parker, Cullman.

The RED DEVIL MANUFACTURING COMPANY, St. Louis, Mo. Capital, $100,000. To manufacture Red Devil Carbon Remover. Incorporators: B. E. Bollinger, Clay E. Herbst and L. O. Honig, St. Louis.

The RIVERSIDE IRON & METAL COMPANY, Paterson, N. J. Capital, $10,000. To manufacture iron and steel. Incorporators: S. and A. Seager, and A. Beaver, Paterson.

The RUBBER INSULATED METALS CORPORATION, Wilmington, Del. Capital, $500,000. To manufacture electrical, chemical, and metallurgical preparations and surfaces for insulated wires, etc.

The SALEM FELTEX COMPANY, Salem, N. J. Capital, $750,000. To manufacture lino-

leum. Incorporators: Neil L. Campbell, Walter S. Shields, and Kenneth Campbell, Salem.

The Schoellner & Horbach Manufacturing Company, Newark, N. J. Capital, $125,000. To manufacture chemicals and allied products. Incorporators: John Schoellner, K. A. Horback, and J. Frowley, Newark.

F. Schoettle, Inc., Philadelphia, Pa. Capital, $200,000. To manufacture paper boxes. W. C. Schoettle, treasurer.

The South Jersey Foundry Company, Camden, N. J. Capital, $250,000. To manufacture cast iron and pipe. Incorporators are: Herbert J. Koehler, K. L. Praisen, and J. F. Sutton, Camden.

The U. & J. Carburetor Company, Chicago, Ill. Capital, $250,000. To manufacture carburetors, etc. Incorporators: J. W. Johnson, Frank A. Urwan, and George E. Brannan, Chicago.

The Union Carbide & Carbon Corporation, Niagara Falls, N. Y. Active capital, $15,000,000. Incorporators: M. T. Herrick, C. G. K. Billings, and C. A. Coffin, 120 Broadway, New York.

The Victoria Iron Works, Northampton, Mass. Capital, $10,000. To manufacture machinery. Incorporators: D. Edward Hennessy, Holyoke; Richard H. Dickson, Holyoke, and F. Hennessy, Holyoke.

The Western Potash & Chemical Company, Ltd., Los Angeles, Cal. Capital, $100,000. To manufacture potash, chemicals, and kindred products. Incorporators: A. Kausek, John L. Prince, E. Oppenhauser, M. B. Bender, L. Miller, John T. Cave, Joseph Rosenblum and Stewart Silliman, all of Los Angeles.

Construction and Operation

Alabama

BESSEMER. — Rapid progress is being made in the rebuilding of the Little Bell furnace of the Tennessee Coal, Iron & Railroad Company at Robertstown, and the company is planning to inaugurate operations before the close of the month. The furnace, which is the oldest of the company in Bessemer, and which has not been in operation for a considerable time, will be devoted to the production of ferromanganese exclusively.

Arizona

KINGMAN. — The Union Basin Mining Company is planning for the immediate rebuilding of its mill and plant at Golconda, recently destroyed by fire at a loss of $250,000.

California

MARTINEZ. — The Butters electrolytic zinc plant at Martinez is starting operations. R. W. French of this city is in charge of the installation of machinery and apparatus. Great Western Power service is being extended into the properties, where enormous quantities of electric power will be consumed in reducing ore.

SAN FRANCISCO. — The Beckman & Linden Engineering Corporation have started the construction of a chemical plant on San Francisco Bay for the manufacture of strontium hydrate, strontium carbonate, strontium nitrate, blanc fixe (precipitated barium sulphate), barium chloride, barium carbonate, barium nitrate and barium peroxide. Mr. Linden states that the new plant will be able to supply the trade in January.

BAKERSFIELD. — Fire recently completely destroyed the refinery of the Union Oil Company in the Kern River fields, near Bakersfield, with total loss estimated at $225,000. The plant will be immediately rebuilt.

FRESNO.—The Pacific Gas & Electric Company is making rapid progress in the construction of its new generating plant on the West Side branch of the Southern Pacific Railroad. The machine shop has been entirely completed, and the main building of the plant is now in course of construction. The works are estimated to cost about $500,000.

FILLMORE. — The Ventura Refining Company has broken ground for the construction of a large refining works to specialize in the production of wax from crude oil. The plant is estimated to cost $300,000. F. E. Snowden is manager.

LOS ANGELES.—Work on the new factory building of the Gilfillan Brothers Smelting & Refining Company at Eleventh and Wall Streets, has been completed, and the company has inaugurated operations for the manufacture of platinum pointed magneto parts, grinders, motor and generator brushes, etc.

SAN DIEGO.—The United States Shipbuilding Company, recently organized, will operate a works for the manufacture of airplanes in connection with its new shipbuilding plant to be erected on the tidelands. A site for the plant has been acquired.

SAN FRANCISCO.—The California Fertilizer Works, Evans Avenue, between Lane and Mendell Streets, are having plans prepared for the rebuilding of their plant which was entirely destroyed by fire recently at a loss of $250,000.

STOCKTON.—The National Paper Products Company has had plans prepared for the construction of a large new paper mill in the western part of the city. The plant will cost approximately $1,000,000. M. R. Higgins is president; A. E. Mandel is manager.

WHITTIER.—A large new one- and two-story chemistry building, about 75 x 156 ft., will be erected at Whittier College, contract for which has been awarded to George A. Daniels, Pasadena, at a price of $25,211.

Connecticut

BRIDGEPORT. — The Raybestos Company, specializing in the manufacture of automobile brake lining, has filed plans for the construction of a new plant on East Main Street, Stratford, Conn. The structure will be one story, about 90 x 180 ft., and will cost $50,000. Contract for erection has been awarded.

PLAINVILLE. — The Trumbull Electric Company, manufacturer of electrical supplies, is making rapid progress in the construction of a new three-story and basement addition to its plant, about 50 x 100 ft. When completed, the structure will cost about $50,000.

Delaware

NEW CASTLE. The Wilmington Fibre Specialties Company has awarded a contract for extensive improvements and alterations in its boiler house and pumping station. Harry Lynch, 715 Tatnall Street, Wilmington, is the contractor.

SOUTH WILMINGTON. — Fire on Oct. 23 destroyed two large buildings at the plant of the Pyrites Company, Ltd., manufacturer of chemicals, etc. This plant has only been in operation for a few months. The loss is estimated at about $100,000. The destroyed structures will be immediately rebuilt.

WILMINGTON.—A portion of the plant of Cahill & Company, Second and French Streets, was destroyed by fire on Nov. 2, with loss estimated at $250,000. The company specializes in the manufacture of automobiles and carriages.

Florida

TAMPA.—The Florida Brewing Company is having plans prepared for the remodeling of its entire plant for the establishment of a sugar refinery, the company proposing to discontinue its regular manufacture. New machinery will be installed for handling about 100 tons of sugar daily. S. V. M. Ybor is manager.

Illinois

CHICAGO.—James H. Rhodes & Company, Twenty-eighth Street and Albany Avenue, are making rapid progress in the construction of a new addition to their plant on the line of the Illinois Northern Railroad. The structure, which will cost about $40,000, is to provide for increased capacity. The company manufactures industrial chemicals.

CHICAGO. — The Inter-Ocean Refining Company, 440 South Michigan Avenue, has had plans prepared for the construction of a new plant on Joliet Road and West Fifty-fourth Street, Lyons, Ill., to consist of kiln house, wax plant, boiler room, office building, filter house, pumping station, stills and auxiliary structures.

DECATUR. — The Comet Automobile Company, Orlando Building, has awarded a contract for the erection of its proposed new two-story automobile plant, about 50 x 80 ft., and one-story building, about 150 x 600 ft., to cost approximately $135,000. The M. J. Hoffman Construction Company, Rookery Garage Building, Evansville, Ind., is the contractor.

CHICAGO.—The Edward Valve & Manufacturing Company, 72 West Adams Street, will build a new one and two-story foundry at its works at East Chicago, Ind., to cost about $15,000. The structure will be about 90 x 150 ft.

Kansas

INDEPENDENCE.—The Carter Oil Company is said to be planning for the construction of a large refinery and is considering sites for the plant in Augusta or El Dorado. The company has leased large areas of land in Cowley, Greenwood and Butler Counties during the past few months, and is planning for extensive development of the properties. The capital has been increased from $50,000 to $4,360,-310. Headquarters of the company are at Tulsa, Okla.

Kentucky

NICHOLASVILLE.—The plant and business of the Central Pigment Company has been acquired by new interests, who are planning to specialize for the present in the production of barytes and fluorspar and at a later date to handle other products.

Louisiana

KENNER.—The Dixie Steel Corporation has acquired a site of 25 acres of land in Kenner, near New Orleans, and is planning for the erection of a new steel plant. Construction of the new works will be started immediately, and it is planned to give employment to about 300 hands for initial operations. This will be the first rolling mill in this section of the country.

NEW ORLEANS.—The Union Seed & Fertilizer Company is planning to increase the capacity of its plant to 40 tons of sulphuric acid daily by the construction of new additions to its sulphuric acid works at a cost of approximately $125,000.

NEW ORLEANS.—A new sulphuric acid plant with daily capacity of 60 tons, is being planned by Swift & Company, Chicago, Ill., at its local plant. The new works are estimated to cost about $250,000. The company is also planning for the construction of a large addition to its local fertilizer manufacturing plant.

Maryland

BALTIMORE.—The Porcelain Enamel & Manufacturing Company, O'Donnell Street, has had plans prepared for the construction of a new one-story addition, about 120 x 220 ft., to its plant on Bayard Street. The structure is estimated to cost about $100,-000.

BALTIMORE.—Plans for the erection of a new three-story machine shop, about 115 x 180 fet, on Ramsay Street, have been filed by Bartlett, Hayward & Company, Scott and Hamburg Streets. Contract for construction has been awarded to Morrow Brothers, Fidelity Building, Baltimore.

BALTIMORE.—The Baltimore Dry Docks & Shipbuilding Company has had plans prepared for the erection of six one-story, brick and concrete shop buildings at its plant.

Massachusetts

HOLYOKE. — The Deane Steam Pump Works, 37 Appleton Street, is building a new one-story brick and steel addition to its plant, about 150 x 165 ft., to cost $50,-000. The Casper Ranger Construction Company, Bond and Appleton Streets, Holyoke, has the contract for erection.

SOMERVILLE. — The American Tube Works has awarded a contract for the construction of a one-story addition to its plant.

SOUTH BOSTON. — F. E. Atteaux & Company, manufacturers of chemicals, have awarded a contract for the construction of a new reinforced-concrete plant, two story, about 65 x 170 ft. The Turner Construction Company, 242 Madison Avenue, New York, is the contractor.

Michigan

DETROIT. — The Ford Motor Company has commenced the construction of its new plant on the 134 acre site recently acquired on the outskirts of the city. The new works will include blast furnaces for the production of steel for their own use, a plant for the manufacture of rubber tires, and a factory for the production of motor car bodies. It is estimated that when completed, the new buildings, including the steel, will represent an exepnditure of approximately $20,000,000.

ECORSE —The Barnes Foundry & Manufacturing Company, Detroit, has taken bids for the erection of a new one-story local foundry, about 164 x 320 ft.

LANSING.—The Duplex Truck Company, manufacturer of motor trucks, is rushing to completion the two new additions to its plant to increase the present capacity. The structures will be two story,

72 x 400 ft., and 72 x 305 ft., and are expected to be ready for occupancy before the close of the month, providing about 100,000 sq. ft. of additional manufacturing space. G. W. Hewitt is secretary and treasurer.

MUSKEGON.—The Advance Brass Manufacturing Company, recently incorporated with a capital of $25,000, has acquired the building formerly occupied by the Racine Boat Manufacturing Company, and is planning to inaugurate operations at an early date. Alex. G. Wilson, Chicago, Ill., is the general manager of the new company.

Minnesota

HIBBING. The Town Council has awarded a contract for the erection of a new coal-gas plant for municipal service to The American Gas Construction Company, Newton, Iowa, at a price of $192,800

Missouri

MIAMI.—The Big Lead & Zinc Company is planning for the immediate construction of a new concentrating plant on property recently acquired about four miles north of this city. The company has been carrying on experimental drilling for some time, and the ore deposits are said to have thoroughly proved up.

NORTH ST. LOUIS.—The St. Louis Malleable Casting Company has acquired three and one-half acres of property adjoining its two-acre site on North Conduit Avenue, and is planning the erection of additions to more than double its present capacity. The new buildings will include an addition to its malleable plant, which incorporates the gray iron department, the erection of a new steel foundry with a daily capacity of 50 tons, and the construction of a small forging and brass shop. The new works will give employment to 700 additional hands.

Montana

BAKER.—Work has been commenced on the initial unit of the new plant to be erected by the Gas Products Company just east of the city, which will be devoted to the manufacture of carbon black. The new works will include the erection of nine additional buildings, the entire plant to represent an investment of about $1,000,000. It is expected that the initial unit will be completed before the first of the year. Fred Engstrom, of Smithburg, W. Va., is superintendent.

WHITEHALL.—The Amalgamated Sugar Company is planning for the erection of a large local sugar refinery to cost about $1,200,000. It is expected that foundations will be ready before the cold weather sets in.

Nebraska

ANTIOCH.—The Western Potash Company has commenced the construction of a large new plant at Artioch, near Alliance, for the manufacture of potash.

New Jersey

CAMDEN.—Fire recently destroyed a portion of the plant of the Waverly Chemical Company, Sixth and Everett Streets, manufacturer of chemicals, with loss estimated at $20,000, principally in machinery. The fire started in the department used for the manufacture of phenolphthalein.

JERSEY CITY.—The National Air Cell Covering Company, foot of Henderson Street, had plans made for the erection of a new one-story and basement reinforced-concrete addition to its plant, about 60 x 305 feet. John T. Rowland, Jr., 100 Sip Avenue, Jersey City, is the architect

NEWARK.—The Tuskaloid Company, 310 East Twenty-second Street, New York, had plans prepared for the construction of a new local factory, one-story, about 100 x 200 feet, at Sussex Avenue and Dey Street, to cost about $10,000. Walter Pryor, 119 Sussex Street, Newark, is engineer. The company specializes in the manufacture of celluloid novelties.

NEWARK.—The Columbus Crystal Company, Avenue R, has taken out a building permit for the construction of a new one-story addition to its plant, about 50 x 185 feet, to cost about $20,000, to provide for increased capacity.

NEWARK.—Work has been commenced on the proposed new plant of the United Color & Pigment Company to be located in Evergreen Avenue. The works will include the construction of a three-story brick manufacturing building, about 70 x 200 feet, and a one-story power house, about 45 x 90 feet. The structures will cost about $65,000.

NEWARK.—The John H. Meyer Tire Duck Company, 708 Frelinghuysen Avenue, has taken out a building permit for the erection of a new two-story brick addition to its plant, to cost about $12,700.

NEWARK. — The Wallington Leather Manufacturing Company, 42 Kent Street, is having plans prepared for the construction of a new plant on Frelinghuysen Avenue to consist of an initial two-story building, about 50 x 150 feet, with smaller building to be used as a power plant, about 48 x 115 feet. Estimated cost of the structures is $40,000. The company is planning to erect a larger building in the near future, with increased capacity for the power plant, the entire works to cost about $150,000.

RAHWAY.—Merck & Company, Lincoln Avenue, manufacturers of chemicals, have awarded a contract for the construction of a new one-story brick addition to their plant, about 44 x 100 feet, to cost $12,000. Salmond Brothers, 526 Elm Street, Arlington, are the contractors.

SOUTH GLASSBORO. — The Whitney Glass Company has completed the erection of its new glass plant, and is planning to inaugurate operations at an early date. The new works will give employment to about 600 hands for initial operations.

NEWMARKET.—The Reade Manufacturing Company, Hoboken, recently organized with a capital of $250,000, has acquired the plant of Gabrielle & Schall, comprising existing works, about 125 x 310 feet, and eleven acres of property, and will establish a refining plant for cobalt and nickel ores. The new owners plan to commence initial operations before the close of the month.

WASHINGTON.—The Washington Porcelain Company, recently incorporated with a capital of $100,000 to manufacture porcelain goods, is having plans prepared for the construction of its proposed new plant, to specialize in the production of electric porcelain specialties. The works will consist of three large buildings, with main structure one-story and basement, 40 x 100 feet, and connecting machine shop, also one-story and basement, 40 x 127 feet. Herbert W. and George Sinclair, and Frank P. Gardner, all of Trenton, head the company. W. A. Kleeman, Second National Bank Building, Trenton, is architect.

New Mexico

DEMING.—Fire recently destroyed a portion of the plant of the Empire Smelting & Refining Company, with loss estimated at $20,000.

New York

NEW YORK.—F. Koshel and S. Singer, 1872 Second Avenue, have had plans prepared for the construction of a new brick smelter, about 20 x 97 feet, on Second Avenue near Fifteenth Street. W. J. Conway, 400 Union Street, is architect.

BROOKLYN.—The Apex Chemical Company, 118 Sanford Street, manufacturer of chemicals, has acquired the plant of the Hygienic Chemical Company at Elizabethport, N. J., and will use the works to provide for increased capacity. The property has a frontage of 308 feet on the Elizabeth River, and was held for sale at about $60,000.

BROOKLYN.—J. C. Wiarda Company, 273 Greenpoint Avenue, manufacturer of chemicals, has awarded a contract for the construction of a new one-story brick addition to its plant at Hudson and Oakland Streets, at a cost of $5,000.

LONG ISLAND CITY.—The Norma Ball Bearing Company, 1790 Broadway, New York, has acquired property on the Boulevard, and is said to be planning for the erection of a new factory.

BINGHAMTON.—The Bayless Pulp & Paper Company, Philps Building, has commenced the erection of a new paper mill at Austin, Pa., to cost about $100,000.

NIAGARA FALLS.—The Niagara Falls Gas & Electric Light Company is planning for the immediate erection of a new gas plant; and the extension of its mains throughout the city to provide for increased capacity.

NIAGARA FALLS.—The Niagara Alkali Company, Buffalo Avenue and Union Street, has awarded a contract for the erection of a four-story benzol plant, about 60 x 80 feet. The Peckham Construction Company, Mutual Life Building, Buffalo, is the contractor.

BUFFALO. — The American Radiator Company, 1807 Elmwood Avenue, is planning for the construction of a brick and steel factory addition, to cost about $55,000.

BUFFALO.—The Kelly Island Lime & Transport Company had plans prepared for the erection of a new one-story lime-burning plant, about 36 x 116 feet, to cost $20,000.

UTICA.—Ground has been broken for the new plant of the McCoy Iron Works, which will be about 100 x 400 feet, at Mortimer and South Streets. The new works will specialize in the production of structural steel. Headquarters of the company are at Perth Amboy, N. J.

Ohio

CLEVELAND.—Fire recently destroyed a portion of the plant of the Cleveland-Akron Bag Company, with loss estimated at $200,000. It is said the plant will be immediately rebuilt.

CLEVELAND.—The Interstate Foundry Company, East Sixty-first Street and the Erie Railroad, has awarded a contract for the construction of a new one-story foundry addition to its plant, about 42 x 88 feet, at a cost of $12,000.

WARREN.—Rapid progress is being made in the construction of the new plant of the Liberty Steel Company, and it is planned to commence the installation of new mill equipment before the first of the year. The company is planning to use the new works for the production of tinplate products exclusively, and expects to inaugurate operations early in February.

Oklahoma

MIAMI.—The Rainbow Zinc & Lead Company is rapidly pushing to completion the construction of its new mill northwest of Quapaw. New equipment will be installed promptly upon completion of the work, and the company is planning to inaugurate operations at an early date.

Oregon

KLAMATH FALLS.—The Grants Pass Iron & Steel Works are planning for the establishment of a large local machine shop and foundry. The new plant will be equipped to handle all kinds of chilled iron, and make semi-steeel castings of all descriptions. B. M. Hall and J. W. Fitzpatrick head the company.

Pennsylvania

PHILADELPHIA. — The Brown Instrument Co. has found it necessary to purchase a large piece of ground located on the south side of its factory. The property of this company now extends along Wayne Avenue from Windrim Avenue on the north to Roberts Avenue on the south, and will permit large extensions to its plant as may be required from time to time.

CLY.—The American Phosphorus Company has acquired property adjoining its plant, and is planning for the construction of a new one-story addition, about 50 x 130 feet, to provide for increased capacity.

LEWIS RUN.—The United Natural Gas Company is making rapid progress in the construction of a new gasoline plant, which will have a capacity of 75,000 gallons daily. More than 50,000,000 cubic feet of gas, which will be secured from the fields of Jefferson. Elk, McKean, Clarion and Forest Counties, will be used daily in the production of gasoline. The cost of the new plant is $150,000.

NORTH LANCASTER.—The Armstrong Cork Company, Pittsburgh, has acquired sixty-five local building lots on the tract of the Lancaster Development Company, and is said to be planning for the erection of a new plant.

PHILADELPHIA. — The Westmoreland Color & Chemical Company, Twenty-second Street and Allegheny Avenue, has awarded a contract for the erection of a new three-story brick addition to its plant, about 20 x 45 feet, to cost $25,000. Rush M. Whiteside & Sons, 2115 Wallace Street, Philadelphia, are the contractors.

POTTSTOWN. — The Pottstown Paper Box Company has taken bids for the construction of a new one and two-story addition to its plant, about 50 x 108 feet, to cost $8,000.

POTTSTOWN. — The National Rubber Company has completed the installation of a large amount of new machinery in its plant, and the company has resumed operations, and is planning to increase its output.

Rhode Island

PROVIDENCE. — The Revere Rubber Company has commenced the construction of a new one-story and basement addition to its plant, about 48 x 64 feet. The new structure will cost about $25,000, and provide for increased capacity.

South Carolina

CHARLESTON.— The United States Government has had plans prepared for the erection of a new incinerator and can sterilizer building at the local navy yards to cost about $30,000.

Tennessee

CENTREVILLE.—The National Phosphate & Fertilizer Company has acquired a number of phosphate tracts in Totty's Bend along the Duck River, at a price of about $185,000, and is planning for extensive development work. The company recently acquired property in the same section at a price of $82,000.

Texas

HOUSTON.—The Humble Oil & Refinery Company has acquired the plant and business of the Dixie Oil Refinery Company, San Antonio, and the company is planning to use the plant for the refining of oil from wells owned by the Humble company in north Texas. The consideration was about $350,000. R. S. Sterling is president.

Utah

ALUNITE.—Fire recently destroyed the large potash plant of the Mineral Products Corporation, near Marysville, with loss estimated at approximately $250,000. The works will be immediately rebuilt. Howard S. Chappell is president.

GUNNISON.—The Gunnison Valley Sugar Company has acquired thirty-two acres of land near the city as a site for a new plant. The work on the factory will be started at once.

SALT LAKE CITY.—The Capital Iron & Metal Company, West Eighth Street, recently incorporated with a capital of $35,000, is rushing to completion work on its new plant, and will inaugurate operations before the close of the month. The company will manufacture babbett metal, ingot copper, brass, pig lead and spelter.

SALT LAKE CITY.—The Utah Oil Refining Company is having plans prepared for the erection of two additions to its plant, to comprise a wax filtering works and a boiler plant, to cost $50,000.

Virginia

IVANHOE.—The National Carbide Company, recently incorporated with a capital of $350,000, has acquired twenty-two acres of land near Ivanhoe as a site for a new plant to be devoted to the manufacture of carbide. Contracts for the new works have been awarded.

Washington

CENTRALIA.—The Pacific Reduction & Chemical Company, recently incorporated with a capital of $500,000, has had plans prepared for the erection of a new coal briquetting plant near Tenino, to cost about $80,000. H. P. Scheel and William McArthur, both of Tenino, and F. M. Lane, of Tacoma, head the company.

West Virginia

FAIRMONT.—The Mononga Glass Company, manufacturer of glassware of all kinds, has awarded a contract for the construction of a new four-story addition to its plant, about 160 x 370 feet, to cost approximately $250,000.

HUNTINGTON.—The Lamie Chemical Company, recently incorporated with a capital of $50,000 to manufacture chemicals, has acquired the old plant of the Blue Jay Overall Company. The company has commenced the installation of equipment, and is planning to inaugurate operations in the very near future.

Wisconsin

MILWAUKEE. — The Standard Steel Company has acquired a site of twenty-three acres for the erection of a new plant for the manufacture of agricultural implements, etc. The company has filed notice of an increase in its capitalization from $50,000 to $300,000 for expansion.

MILWAUKEE.—The Milwaukee Forge & Machine Company is making rapid progress in the construction of its new plant in Lake, which is being erected at a cost of $100,000. The works will comprise a machine shop, 65 x 100 feet, and a forge building, 75 x 140 feet.

Financial

COLORADO FUEL & IRON CO.—The annual meeting of the stockholders and directors of the Colorado Fuel & Iron Company, held in Denver recently, was devoted to consideration of the most prosperous era in the history of the corporation as shown in the report of President J. F. Welborn and the election of directors and offices.

There was but one change in the entire list, that being the advancement of J. B. McKennan to vice-president. He was formerly general manager and will now hold both offices.

John D. Rockefeller, Jr., heads the board of directors. There are five other New York directors, including John H. McClement, Starr J. Murphy, Willard P. Ward, Bertram Cutler and David H. Taylor.

The directors elected from Denver include J. F. Welborn, Joseph Chilberg, Cass E. Herrington, J. B. McKennan, S. G. Pierson, Albert A. Reed and J. A. Writer.

The following officers were elected: J. F. Welborn, president; Starr J. Murphy, vice-president; J. Chilberg, vice-president and manager of sales; S. G. Pierson, vice-president and general purchasing agent; J. A. Writer, secretary and treasurer, and J. B. McKennan, vice-president and general manager.

The following compose the executive committee: J. F. Welborn, Joseph Chilberg, Albert A. Reed, S. G. Pierson and Cass E. Herrington.

The holdover appointive officials are E. S. Cowdrick, assistant to the president; L. B. Rogers and E. V. Cary, assistant secretaries; A. D. Moss, assistant treasurer; Cass E. Herrington, general counsel; Fred Herrington, general attorney; R. H. Hart, attorney; R. L. Hearon, traffic manager; F. H. Bentley, auditor; E. H. Weitzel, manager fuel department; F. E. Parks, manager Minnequa works.

Within the last year the company has caught up on its dividends on the preferred stock and is now paying a dividend on the common stock. The gross receipts from sales for the year ending June 30, 1917, were $40,004,886.78 compared with $25,626,605.54 in the previous year, an increase of 56.1 per cent.

Operating expenses were $31,771,568.23 compared with $21,280,519.74, and net earnings from operation were $8,233,318.55, an increase of $3,887,232.75 or 89.5 per cent.

Income from sources other than operation was $786,283.89, making a total net income of $9,019,602.44, compared with $4,971,076.68 in the previous year.

Mention is made of three increases in wages made during the year. The report concludes:

"During the six months the retirement plan has been in effect, thirty-eight employees have been retired on a total monthly allowance of $849.60.

"Our employees show evidence of satisfaction with working and living conditions and with wages."

GREAT WESTERN ELECTROCHEMICAL.—A special meeting of the stockholders of the Great Western Electrochemical Company has been called for Nov. 28 for the purpose of acting on a proposition to increase the capital stock. It is proposed to increase the company's capitalization from $2,500,000 to $5,000,000 by increasing the common stock from $1,500,000, par value, to $2,500,000 and by increasing the preferred from $1,000,000 to $2,500,000.

President Mortimer Fleishhacker, in his letter to stockholders notifying them of the call for the meeting, says:

"During February last you were notified of an enlargement of our plant at Pittsburg, Cal., and were offered the remaining preferred stock then in the treasury, with certain common stock. This stock was all subscribed and has been issued and the work of this addition practically completed. Since that time it has been deemed wise to build a plant for the hardening of oils, thus utilizing the hydrogen gas produced in our process which heretofore has gone to waste. The company has also found it necessary to increase the capacity of the potassium chlorate plant 100 per cent. in order to take advantage of the large and favorable market for both of these products. These increases in production make it necessary to secure additional working capital.

"That no delay may occur, and in order to provide funds for the additions to the plant and working capital mentioned above, the board of directors has decided to offer to present stockholders (in proportion to their holdings of preferred and common stock), $375,000, par value, of the new preferred stock, and $250,000, par value, of the new common, at the price of $100 a share for the preferred.

LENZ APPARATUS CO.—The capital stock of this company has been increased to $50,000, of which increased capital stock $35,000 have been subscribed and actually paid for in cash, thus giving the company ample working capital to conduct its business profitably, according to the treasurer of the company.

Manufacturers' Notes

NEW SEATTLE ASSAY STORE.—The Assay Supply Dept. of the Stewart and Holmes Drug Co., has opened a new store and headquarters at Third Avenue South and Main Street, Seattle, Wash.

THE WELLMAN - SEAVER - MORGAN COMPANY of Cleveland, Ohio, has established a Seattle office in charge of Mr. Glenville A. Collins. The office is located in the L. C. Smith Building.

THE ELECTRIC FURNACE CONSTRUCTION CO., Finance Building, Philadelphia, announces the following installations of "Greaves-Etchells" electric furnaces: American Radiator Co., Buffalo, N. Y., second order for a six-ton furnace; Stoddard Union Co., Lockport, N. Y., one ton furnace; Primos Chemical Co., Primos, Pa., one special furnace for ferro alloys; T. Waddell & Sons, New Zealand, one two-ton furnace.

SITES FOR CHEMICAL PLANTS.—The great industrial growth about the metropolitan area of New York has brought many new concerns to this section; particularly where acreage is required there has been a great influx to the property bordering the Passaic and Hackensack rivers where the advantage of both railroad sidings and water facilities are good, a great many large chemical concerns locating there recently.

A new section of property aggregating several hundred acres has just been opened up at Fairview adjoining the large soap works of B. T. Babbitt & Company with a frontage of about 10,000 ft. on the Hackensack River bordered by the West Shore and Erie and Susquehanna railroads. Messrs. Wm. D. Bloodgood & Co., Inc., Long Island City, N. Y., have been appointed the selling agents for this property.

New Publications

COKING OF ILLINOIS COAL. By F. K. Ovitz. Bulletin No. 138, published by the Bureau of Mines, Department of the Interior.

ABSORPTION OF METHANE AND OTHER GASES BY COAL. By S. H. Katz. Technical Paper 147, published by the Bureau of Mines, Department of the Interior.

PREPAREDNESS CENSUS OF MINING ENGINEERS, METALLURGISTS AND CHEMISTS. By Albert H. Fay. Technical paper 179, published by the Bureau of Mines, Department of the Interior.

SOME UNIQUE FEATURES OF ELECTRIC ELEVATOR CONTROL. A reprint of a convention address by Harrison P. Reed, engineer with the Cutler-Hammer Mfg. Co., delivered at the Fourth Annual Convention of the Elevator Manufacturers Association of the United States, Oct. 10-12, 1917, Milwaukee, Wis.

POTASH IN 1916. By Hoyt S. Gale. Pages 73 to 171 of Mineral Resources of the United States, 1916—II, published Sept. 10, 1917, at the Government Printing Office at Washington, D. C.

THORIUM MINERALS IN 1916. By Waldemar T. Schaller, pages 223 to 237 of Mineral Resources of the United States, 1916—II, published Sept. 13, 1917, at the Government Printing Office at Washington, D. C.

REFLECTING POWER OF TUNGSTEN AND STELLITE. By W. W. Coblentz and W. B. Emerson. Scientific Paper of the Bureau of Standards, No. 308, issued Aug. 10, 1917.

Manufacturers' Catalogs

THE PREST-O-LITE COMPANY, INC., Indianapolis, Ind., has issued a booklet on "Turning Waste into Profit," devoted to the possibilities of reclaiming broken and worn machinery and metal parts for service by the oxy-acetylene process.

THE DENVER FIRE CLAY CO., Denver, Col., has issued a pamphlet on Caseite Cupels, Bulletin 200 on case crushers and pulverizers, samplers, sieves, mortars, etc., and Bulletin No. 100 on metallurgical clay goods, muffles, crucibles and scorifiers.

THE GEORGE J. HAGAN COMPANY, Pittsburgh, Pa., has issued a bulletin entitled "Twelve Reasons Why Your Choice Should Be the 'Hagan,'" describing the ash conveyor.

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Notice of Removal

The publication offices of METALLURGICAL & CHEMICAL ENGINEERING *have been removed to the new building of the McGraw-Hill Publishing Company, Tenth Avenue at Thirty-sixth Street, New York. All future communications for editorial and business departments should be sent to that address.*

A Time for Patriotism

Our country is at war—at war with a foe who will be defeated only by a supreme, united and concentrated effort. This fact must sink so deeply into the consciousness of every American that it will become the animus of all his acts and the dominating passion of his daily life. Henceforth we must have but one object until it is attained. The great need of the hour is an aroused patriotism that will wipe out prejudice and selfishness, encourage sacrifice and service and unify our every effort.

As a contribution to the attainment of this end we are sending to our readers as a supplement to this issue of METALLURGICAL & CHEMICAL ENGINEERING a colored poster bearing a legend of vital import. The question there asked should concern not only manufacturer, dealer or workman, but also every citizen who is capable of doing more for the protection of "my boy."

Distribution of Niagara Power

In line with the Government's policy to apply the resources of the country most effectively to the winning of the war, we are about to witness official redistribution of Niagara power. Next to an increase in power at that strategic point, the necessity of which we are now sadly appreciating, we presume that a redistribution of such power as we have among the essential industries is the logical step. Certain it is that if the Government is going to demand ferro-alloys and other materials requiring electric power for their production, it must take steps to assure the industries making such materials a supply of power adequate for their needs. And since the total amount of power available is limited to a known quantity, there remains nothing but a withdrawal here and there from non-essential industries and a reapportionment according to essential needs.

Canada recently appointed Sir Henry Drayton royal commissioner to investigate exportation of Canadian Niagara power and controller of the distribution and production of electrical energy in Ontario. Fearful lest there might be an embargo on power from Canada, the United States arranged for a conference between American and Canadian authorities with a view to adopting a priority agreement that would prevent inter-

ference with our making of war supplies for either country.

More recently Secretary Baker has assumed authority in the distribution of American Niagara power, and has appointed Robert Bulkley of Cleveland and Colonel Keller of the Army to make an investigation of the uses of power on this side of the boundary line. American users of power already have been asked to lay before this commission complete statements of the ultimate use and destination of their products so that a conclusion can be reached as to their relative importance for war purposes. The conclusion finally reached by the War Department will depend on the recommendations made by the commission as a result of the hearings and the statistics submitted, and on this basis there is to be a reassignment of power.

No play of fancy or stretch of imagination is required to visualize the pitiful spectacle which our power shortage must present to the enemy, especially an enemy who has shown himself so keenly alive to industrial development and who has been able to prove himself so able an antagonist through his utilization of every natural resource. Congress is about to convene. Water-power legislation is vitally necessary and should be enacted. Will Congress rise to an intelligent appreciation of the situation, or will sentimental and personal obstruction still prevail?

Opportunity for Hydrometallurgy

If this is the day of opportunity for industrial chemistry it holds no less promise for hydrometallurgy. Increased waste and metal loss in lead smelting and zinc smelting, due to the increase in quantity of complex ores treated, is bound to demand attention in the near future; and the success of hydrometallurgy in solving some of the past problems in ore treatment suggests a continuation of that line of attack. In many cases "waste" or "metal loss" represents loss of money in transportation and treatment cost rather than actual loss of metal. As a particular example of this we have the shipment of zinc ores and concentrates containing gold, silver, lead or copper, from Montana and Idaho to Kansas, Missouri or Oklahoma for recovery of zinc, followed by reshipment of the residues to the Rocky Mountain region for extraction of the other metals, and the final shipment of the Western products to Eastern refineries. Another instance of economic loss is found in the treatment of zinky ores and flotation concentrates at lead smelters.

Zinc retort residues from Western ores contain from 30 to 40 per cent carbon, 8 to 10 per cent lead, 6 to 7 per cent zinc, and probably as high as 30 oz. silver per ton. Ordinary methods of concentration have failed to handle this material satisfactorily. Some of it is now burned in heaps in the open air, to remove much of the carbon and put the balance in good physical condition for the blast furnace. This is done without any appreciable loss of metal, and the weight is greatly reduced by the loss of carbon. There remains, however, a large amount of useless gangue with little or no fluxing value, on which freight and treatment costs must be paid. The zinc content is not only troublesome to the lead smelter, but becomes tied up in the slag.

The continued improvement of the flotation process has increased the recovery from low-grade complex ores and has reduced the cost of operation, but the problem of simultaneously separating the constituent minerals has not been solved satisfactorily; and in the minds of some metallurgists we cannot hope for the accomplishment of this end by any form of preferential flotation. A flotation concentrate is not an ideal product for the producer, the railroad, or the smelter to handle, but with modern processes of roasting and sintering it can be put in good condition for the lead blast furnace without serious loss in dust or fume. Nevertheless, increased recovery by flotation means the increased recovery of all the constituent minerals, and this means a zinky product for the lead smelter, relatively lower in lead and higher in silver than a normal concentrate. Again we have a temporary loss of zinc in the slag.

The increasing amount of zinc received at Western lead smelteries from the sources just considered, retort residues and flotation concentrates, is unquestionably increasing the "loss" of this metal in lead slags. This loss probably is due as much to the physical as to the chemical composition of the slag, and would afford an interesting subject for research. Added to the metal loss is the increased mechanical difficulty of operating the furnaces, which necessarily means an increased cost of operation, however small it may be. In any event, we have metal temporarily tied up in the slag, possibly for the next generation to recover, just as the slag dumps of the past have been resmelted at a profit by the present generation.

There are a number of millions of tons of old slag at the lead smelteries of the Rocky Mountain region that probably will contain an average of 100 pounds of zinc, 15 to 20 lb. of lead, and ½ to ¾ oz. silver to the ton. Slags produced to-day will contain an additional 25 to 50 lb. of zinc, 5 to 7 lb. of lead, and ¼ oz. of silver per ton. In the aggregate these losses represent a considerable value.

In the light of these facts, we have two problems: First, to treat complex ores at a common point by a new process, to which retort residues also might be amenable. Second, to develop a process that will successfully recover the valuable metals in lead blast furnace slags. The only feasible method of meeting the physical and chemical conditions involved seems to be one of a hydrometallurgical nature. The treatment of ores at or near their source is being done successfully at Great Falls and at other points in the Northwest, and on or near the Pacific coast. Many troublesome problems have been solved under the beneficial effect of war-time prices for chemically pure products, and the momentum thus acquired probably has carried some of the projects over the shoals of difficulty and expense usually encountered in new processes. There re-

main, however, enough unsolved problems to tax the ingenuity and reward the industry of those who are willing to make the effort.

Reducing the Unessentials

Washington dispatches do not overdraw the proprieties of the case when they assert that the Government authorities intend to proceed very circumspectly in their efforts to curtail unessential industrial activities and to keep their operations as secret as possible. Very truly it is observed that publicity in such matters would tend to disturb business generally and add to the injury of the industries involved.

This procedure of curtailing the unessentials completes the operation of "playing both ends against the middle." The positive operation consists in placing Government orders and requiring that priority be given in their filling, while the negative operation consists in prohibiting operations in various unessential activities. Thus few are going to escape Government regulation by the one means or the other.

A few business men inquired of Washington by what authority this procedure of curtailment was to be undertaken, and received answers equally brief and adequate. The Government has full authority under the Lever act to control the supply of fuel to any industry, while it likewise has power to regulate the railroad movement of raw material to a plant and finished product from it, while under the new draft regulations the employees of an industry are to be classified according to the importance or unimportance of the industry with respect to its contributing to the winning of the war.

It is to be hoped that the operation of regulation will be conducted by the co-operative method. The representatives of the Government and of the industries in question should meet and lay their cards on the table. There should be the utmost frankness on each side. Then, too, it should be remembered that many of our captains of industry owe their success largely to their ability to move a man from one job to another whereby he has become more useful to the organization. The industry that is deemed unessential should be found another job, in which it can help win the war. To a great extent war conditions, operating through natural channels, are serving to assist in the readjustments desired. Many of the things deemed unessential are things for which the demand naturally decreases at this time. Jewelry and watch makers see prospects of their trade decreasing and seek employment in making the finer parts of shells. So far as shop work is concerned, our American methods of standardized construction and interchangeability of parts lend themselves naturally to these changes in industrial operations. The Liberty motor, drawing its parts from many places, is an accomplished fact in this connection, and Henry Ford has been intrusted with a corresponding task in the matter of building standardized ships through the Emergency Fleet Corporation. In turn jobs should be found, if at all possible, for the factories making furniture, musical instruments and other things.

A difficult aspect of the case is the conflicting nature of the two prime desiderata in the program of curtailing in the unessentials. One object is to relieve the burden now resting upon the railroads, and which has badly congested them in the Central West. Another object is the release of labor, to provide more labor elsewhere or to lessen the disturbance caused by the successive drafts to the colors. Now, the industry that involves a large freight movement in its conduct is an industry that, as a rule, employs relatively little labor in its operations, while the industry that employs much labor is usually one that involves relatively little freight movement. It is the one thing or the other, the large volume of material handled, or the large amount of work done upon the material, that makes an industry important from the standpoint of its annual turnover in value. No large number of industries can be selected that would, by curtailment, release both a large amount of freight movement and a large volume of labor.

The burden upon the railroads has not been exaggerated. There is no doubt that the volume of freight offered for transport should be reduced, until the time arrives when the capacity of the railroads can be increased, as by the supply of additional locomotives, or otherwise, for the railroads have become congested and are hauling day by day less freight than would be the case if somewhat less freight had been offered them. This is not the whole story, however. An important economic waste has arisen from the railroad situation, and one that has received little if any public attention, certainly not the attention it deserves. Freight movement requires not merely the physical elements of cars, engines and tracks. It requires also brains and (or) clerical work. It is common gossip, and a fact testified to by many in position to know, that with rising salaries and wages throughout the country, railroads have let valuable men go from their office forces by reason of arbitrary limits set to the salaries which given jobs should pay, often resulting in one $100 man being allowed to go while eventually his work has come to be done by two $75 men. That is an economic waste. Arising from inefficiency in office forces of the railroads there has come another economic waste. In the exigencies of the case shippers in order to secure freight movement have employed high-class men to keep in touch with the movement of their commodities, frequently to make a personally conducted tour with a carload or trainload of freight. The shipper gets results and is willing to pay the price, but when both labor and brains are scarce these practices should be made unnecessary. The clerical forces in the railroad offices should be made adequate to securing the fullest performance from the physical facilities, in cars, locomotives and track, and railroad operations should be so conducted that employees of shippers who are overlooking or personally conducting freight movements can be given other work.

Readers' Views and Comments

The Richards Pulsator Jig in Modern Concentration of Colorado Tungsten Ores

To the Editor of Metallurgical & Chemical Engineering

SIR:—In an article entitled "Modern Concentration of Colorado Tungsten Ores," by S. Fischer, Jr., published in METALLURGICAL & CHEMICAL ENGINEERING, May 15, 1917, we find the following statement:

"Where rich ores are milled, as at the Wolf Tongue Mill, the Richards type of jig works very satisfactorily. It may be said with certainty that the majority of the up-to-date mills use the Harz in preference to the Richards jig."

Mr. Fischer's article may have been compiled some time before May 15, 1917, the date of the article referred to, which led him to state that "the majority of the up-to-date mills use the Harz in preference to the Richards jig," for now nearly all the larger up-to-date mills in the Boulder district have replaced the Harz with the Richards pulsator jigs.

The following is a list of mills using the Richards pulsator jigs in the Boulder district, Colorado:

Installed.	Name of Mill.	Size of Jigs.
April 15, 1916	Duncan Mill	1 12-in. single
Aug. 3, 1916	Wolf Tongue Mill	2 12-in. in series
Sept. 13, 1916	Wolf Tongue Mill	1 6-in. single
Sept. 29, 1916	Vasco Mining Co.	2 12-in. in series
Dec. 26, 1916	Tungsten Metals Corp.	2 12-in. in series
Jan. 31, 1917	Luckie 2 Tungsten Co.	1 12-in. single
March 16, 1917	Vasco Mining Co.	1 6-in. single
April 9, 1917	Primos M. & M. Co.	1 12-in. single
April 17, 1917	Wolf Tongue Mill	2 6-in. single
April 26, 1917	Long Chance	1 6-in. single
June 6, 1917	Boulder Tungsten Min. Co.	1 6-in. single
Oct. 29, 1917	Primos Exploration Co.	2 12-in. in series

In some of these mills using Harz jigs before the installation of Richards pulsator jigs, it was the practice to remove coarse tungsten concentrate accumulating on top of the Harz jig screen by hand-skimming. This left a large amount of ore on the screen for a long period of time, resulting in a considerable production of slime, due to the suction cycle of the Harz jig.

This continual pounding of the tungsten concentrate particles on the wires of the Harz jig screen, together with attrition in the jig bed during the suction cycle, allowed slime particles of tungsten concentrate to escape with the tailing of the Harz jig, thus increasing the loss of mineral throughout the mill operations.

A further disadvantage in the use of Harz jigs, involving the suction water cycle, was that the hutch concentrate would not assay over 30 to 35 per cent WO_3, which is too low grade for shipment, and required sending this product to concentrating tables for retreatment. The suction cycle of the Harz jig draws not only tungsten mineral particles down through the screen into the hutch, but also draws down sand particles which lower the grade of concentrate.

The Richards pulsator jig uses a pulsion water cycle only—no suction cycle—resulting in a loose bed above the screen, allowing very rapid settling of mineral particles and reducing attrition and consequent sliming to a minimum. The concentrate particles discharged from the Richards pulsator jig are sharp and not rounded.

The use of the pulsion cycle only in the Richards jig allows only the heavy mineral particles to fall through the screen into the hutch, thus insuring high-grade concentrate. Instead of a 30 or 35 per cent WO_3 hutch concentrate from the Harz jig, an average of 60 per cent WO_3 hutch concentrate is produced by the Richards pulsator jig, and in some cases as high as 69 per cent WO_3.

In the Boulder district the 12-in. size Richards pulsator jigs are usually applied to the treatment of tungsten ore (ferberite) with feed particles varying from 6 to 8 millimeters maximum diameter to about 1.5 millimeters minimum diameter. Coarse concentrate from above the screen varies from 55 to 65 per cent WO_3. Hutch product produced varies from 60 to 70 per cent WO_3.

A noteworthy example of the application of Richards pulsator jigs to the concentration of pulp usually treated on cencentrating tables of the reciprocating type is found in the use of the 6-in. Richards jigs listed in the above table. These 6-in. jigs treat —1.5 millimeter to 0 pulp, the jig tailing being retreated on concentrating tables. The gates above the screen deliver concentrate assaying 55 to 60 per cent WO_3. The hutch product from these 6-in. jigs assays about 65 per cent WO_3.

In one large mill of the Boulder district the use of these 6-in. jigs, treating the —1.5 millimeter to 0 pulp allowed the removal of two slime tables from the mill and the load on the reciprocating tables was greatly reduced. The concentrate contained a large proportion of mineral grains of a size as fine as 100 or 200-mesh. This is a remarkable result for concentration by jigs and opens a wide field for concentrating fine pulp of ores other than tungsten ores. In this same mill the Richards pulsator jigs produce 60 per cent of all the concentrate recovered in the mill.

Mr. De Witt, superintendent of the Wolf Tongue Mill, Nederland, Col., stated that in connection with the installation of Richards pulsator jigs they "were repaid for all expense in less than 30 days."

The Richards pulsator jig is a most important factor in bringing about the recent improvements in the mills of Boulder County for the concentration of tungsten (ferberite) ores. The result is not only increased capacity, but greatly increased recovery of mineral. The millmen of that district deserve much credit for recognizing merit in a device and using it, even though it replaces an older form of jig practice which was fixed through long established custom.

FRANK E. SHEPARD.

Denver, Colo

Potash from Cement

To the Editor of Metallurgical & Chemical Engineering

SIR:—I have read with a great deal of interest and pleasure your excellent article on Potash, I. W. W. and the Fuel Administration. The figures you give on the cost of production in the Nebraska lake district are particularly interesting.

In this connection I would call your attention to the fact that potash can be produced at a very much lower

cost as a by-product from cement manufacture. Under present conditions our cost here is running approximately $30 per ton of pure K_2O packed on board cars. This, however, is the manufacturing cost and does not include royalty, depreciation and similar items. Under normal conditions of operation it would be possible to reduce this cost very materially, probably by as much as 50 per cent; therefore it would seem that we have here a source of potash which can compete with the German article under any conceivable market conditions.

While the present production of potash from this source is not very great, the potential possibilities are enormous especially when the use of high potash materials for the manufacture of cement is taken into consideration. At the present time there are some half dozen cement plants now installing apparatus for the recovery of by-product potash, one of which, the Clinchfield, is noted in your issue of November 15. All of these companies have been led to go into the matter by the successful example of our plant.

JOHN J. PORTER.

Security Cement and Lime Company, Hagerstown, Md.

Power From Coal

To the Editor of Metallurgical & Chemical Engineering

SIR:—I was especially interested in the power discussion in your issue of Oct. 15. It is easy to agree with those who hold that water power offers the logical solution for the power shortage. At these times, the most portentous in the history of the world, with so much depending on the electrochemical industries, what wanton waste there is in the spectacle of four or five million horsepower idling in the cataract of Niagara!

Mr. Dow in his article on the "Production of Electricity by Steam Power" holds out no hope for the relief of the electrochemical industries through the medium of steam power. The great losses of heat in the production of power through steam being: "The losses necessary to give the necessary draft and the big losses of heat thrown overboard (in the condensing water)—they seem to be inherent in steam." These two major losses constitute about 80 per cent of the heat value of the fuel. Surely a sad situation; for in the case of just one great power-generating station in New York City the equivalent of 2000 tons of coal is wasted daily because of these two heat losses!

I suggest a scheme to save the greater part of this loss. Conceive a cycle embracing:

1. A gas producer of the Mond or similar type, utilizing large quantities of steam.

2. A special steam boiler with great furnace capacity, compared with its heat-absorbing surface, whose fuel is gas from the producer burning in a closed furnace under a pressure of say 150 lb. per sq. in.

3. A gas turbine for the main power production, utilizing as motive-fluid the high-pressure *exit gases* from the steam boiler.

By means of this arrangement I accomplish two great ends:

1. Reverse the usual method for power production through the use in the turbine of the *exit gases*—the products of combustion—and not the steam. And through the use of the latter in the producer its latent heat is largely conserved.

2. Avoid the usual loss in the sensible heat of the exit gases in the ordinary methods of steam raising.

Thus the two difficulties stated by Mr. Dow are solved, and the important by-products of the Mond producer—ammonia and tar—are realized.

The chief problem, however, in the scheme here outlined is the economical compression of both gas and air—to say 150 lb.—prior to combustion in the special closed furnace of our steam boiler. But as single-stage rotary compressors, with an efficiency of over 60 per cent, have been designed, probably the difficulty here is not insurmountable. (I doubt if the Diesel engine, with its multi-stage air compressor and its water-cooled cylinder, can compress its air at an efficiency of 60 per cent.)

With regard to the temperature of the exit gases from our boiler, which are to be conducted direct to the power turbine, this should be in the neighborhood of 1500 deg. Fahr. In arriving at this figure, I estimate that two tons of steam will be required by the producer for every ton of coal gasified, in order to develop the greatest possible amount of ammonia practicable. And the raising of two pounds of steam from every pound of coal gasified should reduce the temperature of the gases from the combustion in the boiler to about 1500 deg. Fahr., or a temperature within the working limits of a properly designed turbine. If you are afraid of this temperature you may water-cool the turbine casing and the shaft, and make your rotor of nichrome or some of the alloy steels containing chromium or tungsten, which hold their strength even at low red heat.

What do your readers think of this idea?

A. C.

Brooklyn, N. Y.

Determination of Phosphorus in High-Speed Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—The writer experienced several emotions when the contribution of Mr. Edward C. Kraus of the Atlas Crucible Steel Co., Dunkirk, N. Y., concerning the determination of phosphorus in high-speed steels appeared in the issue of METALLURGICAL & CHEMICAL ENGINEERING for Feb. 1, 1917. This "modification of present methods" was originated and used by the writer in the fall of 1913 in the laboratory of the Crucible Steel Co. of America, Sanderson Works, Syracuse, N. Y. A brief account of the circumstances leading to the development of this modification will enable competent chemists to utilize the method as given by Mr. Kraus with, perhaps, a little more rapidity, accuracy and intelligence.

In the fall of 1913 the writer was experiencing considerable difficulty in precipitating *in toto* phosphorus from high-speed steels containing about 1.00 per cent vanadium. The method then employed provided for the determination of silicon, tungsten and phosphorus from the one sample, and, in brief, was as follows: Sample was dissolved in 1.20 nitric acid, with the addition of a few cc. of conc. nitric acid. When action had ceased, 25-30 cc. HCl. were added and solution evaporated to dryness and baked one hour. Residue was taken up with conc. HCl, boiled until all iron and chromium salts were in solution, diluted, filtered and washed with 1:10 HCl. Silicon and tungsten were determined by ignition and volatilization of the precipitate. Filtrate was evaporated to 5-10 cc., diluted to 40-50 cc. and precipitated at 70 deg. to 75 deg. Centigrade with molybdic acid solution. Invariably with steels containing vanadium this method

gave low results and a very unsatisfactory "yellow precipitate," very fine, very light and orange in color rather than the "canary yellow" of the usual precipitate.

The writer read a discussion of this problem in an issue of Metallurgical & Chemical Engineering in the fall of the same year. The discussion was written by two chemists of the Government Bureau of Standards, whose names the writer cannot recall, and considered the determination of phosphorus in the presence of vanadium, with no other interfering elements present, such as tungsten. From this article the writer gleaned the following facts:

Vanadium, in the pentavalent stage, interferes with the accurate determination of phosphorus by the usual routine "yellow precipitate" method. Vanadium seems to react with the molybdic acid solution in various ways, according to the vanadium content; with a vanadium content up to 0.35 per cent, vanadium does not seem to interfere with the precipitation of phosphorus, but seems to be partly precipitated with the phosphorus giving the precipitate the orange color mentioned above, and yielding a higher calculated percentage of phosphorus than is true; with a vanadium content over 0.4 per cent vanadium interferes with the precipitation of phosphorus, but is itself precipitated as already described, but giving low results.

The vital point in the method proposed by these chemists was the reduction of vanadium from the pentavalent stage without reduction of the phosphoric acid present, and in eliminating any unnecessary excess of nitric acid, which tended to reoxidize the vanadium after it had been so reduced. The reduction was done by the use of a saturated solution of ferrous sulphate; the excess nitric acid was eliminated by neutralizing the solution with ammonia before precipitation with the molybdic acid solution.

The writer's problem was to adapt this method to a steel containing a high percentage of tungsten in addition to a comparatively high percentage of vanadium. The procedure adopted by the writer after careful experiment was as follows: Tungsten was removed as in the original method if quantitative determination was desired, otherwise sample was dissolved in 50 cc. aqua regia and evaporated to 10 cc. The writer has never found it necessary to oxidize an aqua regia solution with potassium chlorate as suggested by Mr. Kraus. The solution was diluted and tungsten filtered off and washed three or four times with 1:1 HCl. (hot). Filtrate was then evaporated nearly to dryness to drive off as much Cl. as possible, diluted to 40-50 cc., heated to 70 deg. to 75 deg. C., and removed from the hot plate. Five cc. saturated solution ferrous sulphate and 5-8 cc. of 6-8 per cent sulphurous acid were added and phosphorus precipitated by molybdic acid as quickly as possible. If vanadium content was over 1.25 per cent, 10 cc. ferrous sulphate solution and 10 cc. sulphurous acid were added, as the nitric acid present in the molybdic acid solution seemed to reoxidize vanadium when present to that extent. Some writers warn against the use of excess ferrous sulphate because of its reducing action upon the phosphoric acid present. The writer carefully investigated this phase of the problem and found no apparent loss of phosphorus by the use of ferrous sulphate as outlined above. By using this modification the writer obtained a phosphorus percentage as high as 0.056 from steels which yielded as low as 0.004 by the original method. He has had very good success in checking this modification against Government Standards as well as against other methods of eliminating the interference of vanadium.

The *raison d'etre* of this communication is to give credit to whom credit is due. The research and conclusions upon which this modification is based were the work of the two chemists of the Bureau of Standards and to them the greatest credit must be given.

W. T. Sheffield.
Mohawk Improvement Co.

Meeting of New York Section, American Institute of Mining Engineers

Legislation affecting the mining and metallurgical industries was the subject of discussion at a meeting of the New York Section, A. I. M. E., Nov. 26, 1917. Taxation, price fixing, priority rulings, etc., were considered, with a view to making constructive suggestions to the Government for equitable treatment of mining and metallurgical companies.

It was clearly established that the metal industry wants to pay its share of war expense and that equitable taxation is welcome. It was quite as clearly shown, however, that the present law on excess profits taxation is unjust to mining companies as compared with manufacturing concerns. Before the meeting adjourned a telegram was addressed to the congressional committee at Washington, which is advising the Treasury Department on the construction of the law, urging that Sec. 207 of the war income tax law be construed so that "earned surplus" will include ore in place susceptible of valuation; and further that companies should be permitted to value their property as of the present irrespective of their capital stock or date of incorporation.

With regard to price fixation the general sentiment seemed to be that if the Government is to get the supply of metals it needs, it must be willing to pay prices that will insure production, and that there must be assurance that those prices will not go below a level at which operations can be conducted at a fair profit. There was some difference of opinion as to the efficacy of price fixation, owing to the intricacies of the metal-producing business which were not fully understood by the Government and which could not be taken fully into account in fixing prices. Some speakers favored no fixing of prices and free play for the laws of supply and demand.

Meeting of New York Section, Society of Chemical Industry

By-product recovery of potash from wool-scouring waste and Portland cement formed the basis of an interesting program at the regular meeting of the New York Section, Society of Chemical Industry, Nov. 23, 1917.

Mr. R. S. Weston explained the principles underlying modern disposal of wool-scouring waste for the recovery of oils, fats, waxes and potash.

The manufacture of Portland cement was explained by Mr. E. D. Boyer of the Atlas company. The paper was supplemented by moving pictures showing the complete process of cement making from the quarrying of the rock to sacking and shipping the ground product. The recovery of potash from kiln dust was explained.

Information on Industrial Poisons

The importance of conserving labor in the present national crisis and the necessity of properly safeguarding men working in various industries, directs attention to the subject of industrial poisons. About the only information published on this subject is that secured and compiled by the Bureau of Labor Statistics, U. S. Department of Labor, with the ever-widening scope of national industry comes the disclosure of industrial poisoning and the discovery of new dangers for the workmen engaged. A recent instance is found in dope poisoning in the manufacture of airplane wings due to the use of cellulose nitrate or acetate dissolved in tetrachlorethane. Other examples are toxic jaundice in munition workers, poisoning from the exhaust gases from gasoline engines, and the more common troubles from metallurgical and chemical gases, fumes and dusts.

The wide diversity of industries in which the poison menace may occur makes the gathering of information on the subject slow and difficult. The Bureau of Labor is constantly investigating the instances that come to light, but co-operation is needed on the part of those directly concerned. For this reason we invite contributions pertinent to the metallurgical and chemical industries. Valuable information will be found in the Bureau's Bulletin 100, which classifies and lists industrial poisons and other substances injurious to health. This is now under revision, and the Bureau will appreciate co-operation in bringing it up to date.

Advisory Board of Chemists for Bureau of Mines

Because of the great amount of war work being done by the Bureau of Mines, Secretary of the Interior Lane has asked six of the prominent chemists of the country to act as an advisory board to the bureau.

The members of this board are: Dr. Wm. H. Nichols, General Chemical Company, New York, chairman of the board; Prof. H. P. Talbot, head of the chemical department of Massachusetts Institute of Technology, Boston, Mass.; William Hoskins, consulting chemist, Chicago, Ill.; Prof. H. P. Venable, head of the chemistry department, North Carolina University, Chapel Hill, N. C.; E. C. Franklin, professor of chemistry, Leland Stanford University, Stanford, Cal.; and Dr. Charles L. Parsons, chief chemist of the Bureau of Mines.

The board will discuss and advise upon gas warfare research, the minerals specially needed for munitions, and the recently enacted law for the regulation of explosives.

Plan to Fix Basis for Zinc Prices

Producers of zinc organized a committee Nov. 13 to co-operate with the War Industries Board in fixing a basis for establishing prices for the various grades of the product. The committee was formed following a consultation on Nov. 12 between the zinc men and Eugene Meyer, Jr., who has charge of purchases of non-ferrous metals for the government. The members are Edgar Palmer of the New Jersey Zinc Company, chairman; Charles T. Orr, Cornelius F. Kelly, C. M. Loeb, Sidney J. Jennings, N. Bruce McKelvie, Charles F. Baker, Walker W. Vick, R. A. Cowles, A. P. Cobb, E. W. Furst, S. M. Evans, J. D. Lang and S. S. Tuthill.

The committee is expected to hold frequent meetings until the necessary data for study by the War Industries Board have been gotten together. A method for establishing prices for zinc ore is also to be studied and recommended to the Washington authorities.

Annual Report of the Bureau of Mines of 1916

From advance sheets of the Yearbook of the Bureau of Mines—1916, we make the following pertinent excerpt:

Probably no year in the history of the United States showed greater progress in the mineral industries than 1916. Although this progress was undoubtedly stimulated by the war in Europe, which caused extremely high prices for some of the metals, yet the fact remains that mining is being regarded more as a business and less as a speculation, and the benefits of business methods are becoming evident. Practices that were almost universal a few years ago have been largely abolished, the mining public has been brought to recognize the folly of wasteful and dangerous methods, and there is a gratifying unanimity of opinion in regard to the conservation of life and health, as well as of our mineral resources. The people of the United States realize more fully than ever before the extent and value of the country's mineral resources and the possibilities that await intelligent and well-directed efforts at utilization.

In response to numerous requests for assistance in evolving suitable processes for treating the low-grade complex sulphide ores of the Silverton district, Col., the bureau undertook an investigation of these ores. Late in May, 1913, a junior geologist of the Bureau of Mines was sent to the Silverton district to conduct the investigation.

The bureau's representative has carefully studied the conditions in the district and has collected many samples of the various ores. From these samples polished sections were made for a metallographic study, which has already yielded much valuable information as to the composition and character of the ores and the reasons for the low recovery obtained by the concentrating methods used. The next step will be investigation to ascertain the proper means of concentration.

One of the most important and far-reaching lines of investigation being carried on by the Bureau of Mines pertains to the most efficient and economical methods of utilizing our fuel supplies and the various products derived from them.

Tests as to the production of gas from lignite have been made by several methods under a variety of conditions of temperature, time and other modifying factors. The lignites have been found to yield much gas, its quality and character varying, of course, with conditions of production. The power tests indicate that it can be successfully employed to drive gas engines and that in such Western lignite regions as are without water power, power can be produced at such a low figure as to exert a marked influence in the development of a variety of industries dependent upon a cheap and abundant power.

Study has also been given to the carbonization of lignite, with the subsequent production of briquets, ammonium sulphate, tar and oils.

Investigations in mineral technology covered the mining, concentration and treatment of carnotite ore for the recovery of radium, uranium and vanadium. In co-operation with the National Radium Institute, the bureau produced more than eight grams of radium. A considerable amount of work was done on the treatment of molybdenum ores and on the production of rare-metal alloys containing molybdenum, tungsten, uranium and vanadium.

The non-ferrous alloy investigations of the bureau have been conducted in co-operation with Cornell University. The problem concerns mainly the metal losses in the brass industry and the evolution of a suitable type of electric furnace for brass melting. The melting of aluminium chips and the production of ferro-uranium are other problems under investigation at Cornell.

A ceramic research has been conducted on the Kaolins of Georgia to see if some of our vast deposits of impure white clays could not be refined sufficiently to permit of substitution for foreign materials. The problem has been attacked with the methods of colloid chemistry.

Among petroleum investigations of importance are the methods of producing gasoline from the less valuable products of crude oil, and the extraction of oil from oil shales. Shale oil has never been produced in this country until recently, owing to our large oil reserves, but it will be only a very short time until the oil-shale industry will be one of magnitude.

The metallurgical investigations of the bureau have been extensive and cover corrosion of metals, fluidity of blast-furnace slags, brine-leaching of low-grade and complex ore containing lead, the application of the flotation process to ore slimes, production of zinc dust from solutions of zinc, sulphurous acid process for copper and zinc-lead ores, behavior of alluminium in cyanide solutions, efficiency of crushing machines, smelter fume investigations and sulphur recovery processes. The complete report of the bureau is an interesting review of progress.

Chemical Investigation of United States Tariff Commission

Section 501 of the Act of Congress, dated Sept. 8, 1916, provides for the taking of a special census of the production of intermediates, dyes, and other coal-tar products in the United States. The act provides: "If, at the expiration of five years from the date of the passage of this act, the President finds that there is not being manufactured or produced within the United States as much as 60 per centum in value of the domestic consumption" of intermediates and dyes, medicinals, and other finished products, "he shall by proclamation so declare, whereupon the special duties imposed by this section on such articles shall no longer be assessed, levied, or collected." *The President has requested the Tariff Commission to undertake the collection of information necessary for the exercise of this power.*

The commission is preparing for a systematic census of the production of all coal-tar products in a broad sense, including intermediates, dyes, medicinals, flavors, photographic chemicals and synthetic phenolic resins.

The Geological Survey has been for many years collecting statistics on the operation of coke-oven plants, including production of the by-products coal tar, benzol, toluol and naphthalene. Arrangement has been made whereby duplication of work will be avoided by co-operation between the Survey and the Tariff Commission. Under this arrangement the Survey will continue to collect all the information on the operation of coke-oven plants which it has been collecting in the past, and in addition it will (1) distinguish between crude and refined naphthalene, (2) make an inquiry in regard to the manufacture of any intermediates at coke-oven plants, (3) collect annually the statistics on the operations of gas houses, (4) ascertain and report to the Tariff Commission confidentially information in regard to the disposal of the materials, specified above, produced and sold by the coke ovens and gas plants. The Tariff Commission will not go directly to the coke plants or gas houses, but will secure statistics on the production of these plants from the Geological Survey.

The Tariff Commission will make a detailed inquiry in regard to the development within the United States of the complex chemical industries which convert these by-products of the coke ovens into finished dyes, medicinals, photographic chemicals, flavors, and synthetic phenolic resins. Over 150 firms are now engaged in the manufacture of these products within the United States.

The Tariff Commission will not make an independent inquiry in regard to the production of explosives in the United States, since other departments of the Government are following this closely. The commission, however, will ascertain the production of intermediates derived from coal tar and used in the making of explosives, such as diphenylamine used in the making of guncotton for stabilizing smokeless powder. These intermediates, which are specifically mentioned in the act, may be diverted to making dyes when the normal demand for explosives ceases.

The general investigation of the commission into the chemical industries is progressing. Conferences have been held with interested specialists and with heads of other bureaus collecting information of a similar or related character, factories have been visited by agents of the commission, the products affected have been classified, and information upon them is being compiled. A general questionnaire, designed to secure information in regard to the competitive conditions in the chemical industries, will be sent out. Special emphasis will be laid on the branches of the chemical industries which have shown the most revolutionary changes during the war.

Service Overseas for Chemists

The Chief of Ordnance, War Department, announces that chemists are wanted for early service overseas in the Enlisted Ordnance Corps, National Army. Men between the ages of 18 and 40, who wish to engage in this work, and consider themselves competent to serve, are urged to communicate at once with the Chief of Ordnance, War Department, Washington, D. C. There is a lot of work to be done and the army which has the best equipment and best men is the army that is going to win. Experts in various lines are badly needed, and chemists will find here an opportunity for patriotic service.

Mill Pumping Systems

By A. W. Allen

The selection of a suitable system for mill pumping involves consideration of several important factors. Owing to the varied conditions of work and the different characteristics of the fluids to be elevated, the principal requirement is suitability; *i.e.*, the system decided upon should involve minimum attention for control and repair, and must operate at a reasonable efficiency. Elevation of pulp and solution are phases of milling work in which continuity of operation is of primary importance, and for this reason every opportunity should be taken in the first instance to install a machine which will do the work without unnecessary attention, or demand an excessive loss of running time for repairs and renewals.

It is convenient to subdivide the apparatus more commonly used for this purpose into nine divisions, according to the class of material to be handled and the height to which it must be elevated. Table I shows

TABLE I—MILL PUMPING SYSTEMS

Material to be Pumped	Low Lift (to 25 Ft.)	Medium Lift (to 50 Ft.)	High Lift (to 100 Ft. or More)
Water or solution.	Air-lift Frenier pump Centrifugal pump	Centrifugal pump Compound air-lift	Plunger Pump (1, 2, or 3-throw) Compound centrifugal pump
Slime pulp.....	Air-lift Diaphragm pump Frenier pump	Compound air-lift Centrifugal pump	Plunger pump (1, 2, or 3-throw)
Sand pulp.....	Centrifugal pump Air-lift Frenier pump	Centrifugal pump Tailings wheel	Plunger pump (3-throw)

the applicability of eight classes of pumps for different kinds of work. A selection is usually made from among these.

Water or Solution

LOW LIFT

For this work it is usual to employ either the centrifugal, the air-lift, or the Frenier pump. In point of efficiency with good design, they may be considered in the order named. The operation of the air-lift or the Frenier pump insures an aëration of the water or solution. This is sometimes an advantage, sometimes a disadvantage. In the latter event the centrifugal will be chosen as the most suitable.

For compactness, and ability to drive by direct motor connection, the centrifugal will also be favored. For fairly efficient operation with a variable supply and with automatic control, the air-lift may be considered as superior to either of the other machines mentioned. Where compressed air is not available, the choice will lie between the centrifugal and the Frenier, with a probable decision in favor of the former on account of greater compactness, higher efficiency, and larger capacity.

For small-capacity, low-lift circulating work, a single-plunger pump or diaphragm pump is sometimes used, and arranged for variable stroke by means of an eccentric adjustment.

MEDIUM LIFT

For this work there is little to choose between the centrifugal and the compound air-lift, although the latter is generally chosen on account of greater compactness.

HIGH LIFT

For high-lift work, the compound centrifugal or the plunger pump is usually adopted. The greater comparative flexibility of the latter under varying conditions of speed and lift indicates a point of superiority over the centrifugal.

Multiple-throw plunger pumps are to be preferred, otherwise a heavy flywheel is advisable. A submerged suction saves time and trouble, especially in the case where an incrustation is liable to form on the valves, which results in the pump frequently losing its suction water.

Slime Pulp

LOW LIFT

The advantages of the air-lift for slime pulp elevation are too well known to need elaboration. At the present time, however, it is being largely superseded in low-lift work by a diaphragm pump with adjustable stroke. This latter adjustment has not yet been designed to operate automatically with a varying flow of pulp, as may be arranged with the air lift. The diaphragm pump is, however, particularly well suited for low-lift work, and its ability to counterbalance the difference between the static head of the average of the thin pulp in a tank and the thick pulp at the discharge without loss of fall has resulted in its wide adoption to handle the sludge from mechanical thickeners.

The application of the diaphragm pump as regards height of lift is exceedingly limited. Table II shows

TABLE II—APPROXIMATE THEORETICAL SUCTION AND DIAPHRAGM PUMP LIFTS (AT NORMAL TEMPERATURE)

	Specific Gravity of Fluid							
Altitude	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700
	Maximum Suction Lift in Feet							
Sea level	34	31	28	26	24	23	21	20
1,000 ft.	33	30	27	25	23	22	21	19
2,000 ft.	32	29	26	24	22	21	20	18
3,000 ft.	31	28	25	23	22	20	19	18
4,000 ft.	29	27	24	23	21	20	18	17
5,000 ft.	28	26	23	22	20	19	18	17
6,000 ft.	27	25	22	21	19	18	17	16
7,000 ft.	26	24	21	20	19	17	17	16
8,000 ft.	25	23	21	19	18	16	16	15
9,000 ft.	24	22	20	18	17	16	16	14
10,000 ft.	23	21	19	18	17	16	15	14

theoretical possible lifts, but owing to slow speed and entangled air in the pulp, and the difficulty in maintaining the vacuum under normal conditions, this class of pump usually operates at from 25 per cent to 50 per cent of these amounts.

Heating of pulp is sometimes a necessary phase in ore treatment. Its effect on diaphragm-pump operation may be estimated by reference to Table III.

Frenier pump-capacity data are given in Table IV. The fixed output from this type of pump is a disadvantage. It deals unsatisfactorily with an underload and cannot cope even temporarily with an overload. Height of lift is controlled by the diameter of the spiral, and no variation in normal speed (about 20 r.p.m.) can affect the result. Efficiency of operation demands that the pulp in the box be kept at a uniform level. To insure this it is often found advisable to oversupply

TABLE III—EFFECT OF TEMPERATURE ON SUCTION AND DIAPHRAGM PUMP LIFTS

Deg. Fahr.	Approximate Theoretical Suction Lift in Feet, for Water, at Sea Level
60	34
80	33
100	32
120	30
140	27
160	23
180	16
200	8

TABLE IV—APPROXIMATE FRENIER PUMP CAPACITIES

Size, Inches	Specific Gravity of Fluid					
	1,000	1,100	1,200	1,300	1,400	1,500
	Tons per 24 Hours					
44x 6	45	49	54	58	63	67
48x 6	45	49	54	58	63	67
54x 6	45	49	54	58	63	67
44x 8	54	59	65	70	76	81
48x 8	54	59	65	70	76	81
54x 8	54	59	65	70	76	81
44x10	63	69	76	82	88	94
48x10	63	69	76	82	88	94
54x10	63	69	76	82	88	94

the pump and allow the surplus to be handled by an arrangement such as an auxiliary air-lift arranged for automatic operation.

All three types of pumps used for low-lift slime pulp elevation operate without the necessity for gland clearance water, and are, therefore, suitable in the case where any further dilution of the pulp is undesirable.

The use of centrifugal pumps for agitating the contents of large vats by low-lift pumping is of sporadic occurrence. The results are invariably the same. The fact that (1) actual agitation is confined to the comparatively small percentage of the pulp passing through the pump; (2) there is nothing to prevent settlement of the solids around the sides of the vat; and (3) that a continuous supply of diluent to the pump glands is needed, are sufficient reasons against the adoption of the scheme.

Low-lift slime pulp handling by centrifugal pumps is, however, a feature of decantation practice, and illustrates a method of utilizing to the full the characteristics of these machines. Ample dilution is desired, and thorough mixing is insured by the operation of the pump, which delivers at high capacity. Pulp transference may thus be made in the minimum of time and settlement commenced at the earliest possible moment. A 12-in. pump of this class will handle about 2000 tons of 4 to 1 slime pulp per hour; and if only natural or true slime constitutes the solid portion of the pulp, the wear on liners and runners is comparatively low.

HIGH LIFT

The multiple-type plunger pump is to be preferred, and ball valves are suitable. Arrangements must be made for a supply of clearance water under pressure to be delivered around the plunger and below the stuffing boxes, to prevent undue scouring of the plungers against the packing. The importance of clearance-water provision is such that it is advisable to operate the opening and closing of this service by direct connection with the belt strike or clutch operating the pump. Neglect of this precaution may result in considerable damage to the plungers and the necessity for the renewal of the packing.

The correct pressure of clearance water is best maintained by the provision of a small tank fitted with overflow, and placed above the level of the apparatus receiving the pump discharge, and at a height whch takes into consideration the weight of the material being handled.

Sand Pulp

LOW LIFT

In point of efficient operation the centrifugal probably claims first place for handling coarse sand in pulp for low lifts. Normal velocity for this machine is high when comparison is made with the air-lift or the Frenier pump. Hence the greater ability of the centrifugal to keep grains of sand in suspension until the discharge point is reached. The question of the suitability of either of the other class of pumps for this work will depend on the size and specific gravity of the grains of material comprising the solids in the pulp. If there is a tendency to settle quickly, then the centrifugal should be adopted. If pulp dilution with gland clearance water, essential to the operation of the centrifugal sand pump, must be avoided, then the matter is outside the purview of this article, and the installation of a belt-and-bucket or belt elevator should be considered.

MEDIUM LIFT

In spite of its wide adoption for this class of work the centrifugal has its disadvantages. Given an automatically-operated water service for gland clearance, which will certainly save the shaft if laid true, there is usually considerable trouble caused by the wear of liners and runners on account of the comparatively high speed necessary for effective operation. This wear causes erratic results long before it is necessary to hang up for repairs or renewals. If anything like continuity of operation is desired it is always advisable to erect in duplicate.

The tailing-wheel is ungainly in appearance, and could not be considered in the compact, covered-in mills where the winter is severe. In other localities, however, it has its good points, not the least of which is the fact that first cost is practically last cost. If well made in the first instance, it needs little attention, and practically no repair.

An additional point in favor of the tailing wheel is that although efficiency is not high (50 per cent to 60 per cent) it is certainly uniform under varying conditions of elevation and capacity, for which the details may be estimated with comparative facility. With a centrifugal, on the other hand, there must be a definite speed for each lift, and the runner must be carefully designed and correctly proportioned for the work it is called upon to do. When lifting above 25 ft. or so such pumps often exhibit an abnormal power consumption, which the average millman is at a loss to account for.

Comparative results of the operation of the tailing-wheel and centrifugal pump for medium lifts show a considerable economy in favor of the wheel, even when its high capital cost is taken into consideration. This is largely due to the lower efficiency of the centrifugal (40 per cent to 50 per cent) and the fact that the work

done for power expended decreases as the liners wear.

Sand pulp is often classified or screened after elevation. Apparatus for this purpose, without exception, will work more efficiently if given a steady feed. The pulsating flow from a centrifugal pump when the liners and runners are becoming worn is a feature against its adoption in the case where a uniform delivery is desired.

HIGH LIFT

Multiple-plunger pumps adopted for this purpose preferably should be arranged so that the suction is submerged. The supply tank may be equipped with a mechanical stirrer so that all the sand is kept in suspension. If an ordinary box is used for this purpose there is danger of the sand banking up on the sides. This usually leads to periodic slides of heavy material towards the suction, and invariably causes trouble. Particular care must be taken in the adequate provision of pressure clearance water, the same precautions being observed as with slime pulp.

The efficiency of the plunger pump increases with the lift; and for the high lifts required in ordinary mill work it usually averages about 70 per cent.

The necessity for the elevation of heavy sand in water for considerable vertical distances is luckily rare in most instances. Compound centrifugal pumps, or single-stage pumps worked in series, might be used; but the scouring action of the sand at high velocity represents much lost energy, causing unreasonable expense, and necessitating frequent attention for renewals. To obviate this trouble the pulp may be handled in a classifying dewaterer, the thin slime being pumped by either of the systems available and the wet sand elevated by means of a belt or belt-and-bucket elevator.

New York, N. Y.

The principal aluminum salts made in the United States, according to the U. S. Geological Survey, are alumina, alums, usually ammonium and sodium alums, aluminum sulphate, and aluminum chloride. Alumina is largely consumed in the manufacture of aluminum, and no figures of domestic production are available. Alums of various qualities are produced at 9 plants in the eastern United States, the total production of alum in 1916 being 27,257 short tons, valued at $1,177,881, an increase over 1915 of approximately 10 per cent in quantity and of 68 per cent in value.

Aluminum sulphate is made at 18 plants, 6 of which are located at municipal or industrial waterworks, which consume their entire output. The total quantity of aluminum sulphate produced in the United States in 1916 was 153,860 short tons, of which 6037 short tons did not enter the market but was used for water purification at the place of manufacture. The quantity of domestic aluminum sulphate which entered the market, 147,823 short tons, was less than the quantity in 1915 by 12 per cent, and the total domestic production fell off about 9 per cent. The value of the total production of aluminum sulphate in 1916 was $4,410,741, an increase of nearly 37 per cent over the value of the greater production of 1915.

Aluminum chloride is used for various purposes, among which may be mentioned the refining of mineral oils. This salt was produced at 5 plants in 1916, the total output being 3322 short tons.

The Physical Basis of Color-Technology

By M. Luckiesh

Physicist, Nela Research Laboratory

In the color industries the chemist has long been a mighty factor, but the physicist has not been generally accepted as being essential in this field. In fact, much of the physics of color is so little used in some of these activities that it is either not generally understood by those in charge of the technique, or its value is underrated. Spectral analyses, the quantitative determinations of the spectral characteristics of colored materials, provide the foundations for many important aspects of color-technology and without such data progress must be left to grope its way more or less blindly. With such data, and those derived from less analytical methods, many interesting facts and relations can be revealed and various factors can be studied which are unapproachable from the viewpoint of chemistry or from ordinary inspection. In delving into the physics of color many avenues of research in the development, manufacture and refinement of colored media suggest themselves. This entire subject cannot be covered adequately in a brief article, but perhaps an idea of the physical basis of color-technology may be gained from this presentation. An extensive treatment of apparatus, methods and data will be found elsewhere[1] and additional spectrophotometric data have been presented in a recent paper.[2]

THE RELATION OF THE ILLUMINANT

In dealing with colored media the illuminant is always a prominent factor, so it must be remembered that light and color are very closely related. In general, an illuminant consists of radiant energy of many different wave-lengths, a narrow range of which are capable of exciting the sensation of color. The energy of the shortest wave-length which is visible to the eye causes the sensation of violet and that of the longest wave-length which is visible excites the sensation of red. Between these two extremes the visible spectrum is found. The invisible radiant energy of short wave-length is called ultra-violet, and excites fluorescence, phosphorescence, chemical action, and many phenomena which are of interest to the color-technologist. The invisible energy of long wave-lengths is called infra-red and it possesses interesting relations to colored media.

The color of an object can hardly be considered as being inherent in the object because it depends upon the spectral characteristic of the illuminant. Any colored medium transmits (or reflects) radiant energy of an appreciable range of wave-lengths and, therefore, if the relative amounts of the energy of the various wave-lengths in this region differ for two illuminants, it should be obvious that in general the colored medium will appear different under the two illuminants. Furthermore, the reflection (or transmission) factor (sometimes called reflection coefficient) of a colored medium will not be constant but will depend upon the illuminant. These and many other points seem to be misunderstood, but it should be obvious that the illuminant should be considered as almost a part of a colored medium.

In Fig. 1 is shown a curve of the spectral reflection-

[1] Color and Its Applications, 1915, D. Van Nostrand Co.

[2] The Physical Basis of Color-Technology, Jour. Frank. Inst., 184, p. 73 and 227, 1917.

factors of ultramarine-blue pigment and also spectral luminosity curves of this pigment for three illuminants. The latter curves enclose equal areas and therefore represent the appearance of the spectrum of this pigment to the eye for equal total amounts of light reflected as explained later. From these an idea of the appearance of the color can be formed after some experience, or conversely, the reason for these different appearances under the three illuminants is manifest. It is seen that this pigment is of a purer color under skylight than under either of the other illuminants. The wave-lengths of maximum luminosity are 0.495μ and 0.54μ respectively for skylights and tungsten light. This wave-length of maximum luminosity is not necessarily the dominant hue of the color as analyzed by the eye or by the monochromatic colorimeter (discussed later), although these are often nearly coincident. Under the tungsten light the effect of the increasing reflection-factor toward the red end of the spectrum becomes evident. It will also be noted that this pigment becomes very ruddy in appearance under ordinary artificial light.

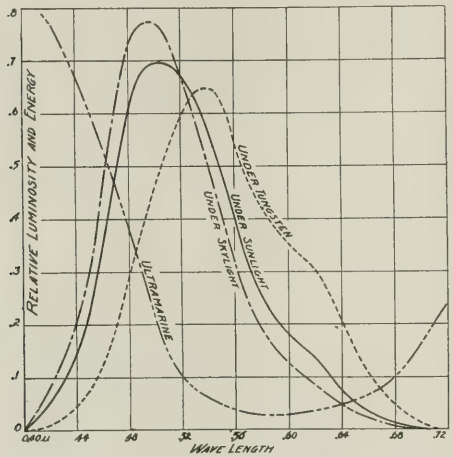

FIG. 1. INFLUENCE OF THE ILLUMINANT ON THE APPEARANCE OF ULTRAMARINE PIGMENT

THE ANALYSIS OF COLOR

Of the various methods of analyzing color, that of the spectrophotometer is the most analytical, and it provides data of far greater usefulness in the physics of color than the data which are yielded by any of the other methods. By this method the reflection (or transmission) factors of the coloring media are determined for radiant energy of all wave-lengths in the visible spectrum. When these are plotted we have the spectral reflection (or transmission) curves for the visible spectrum. By the same method the spectral character of an illuminant may be obtained. By multiplying the relative energy-values of the various wave-lengths of any illuminant by the corresponding visibilities of radiation, the spectral luminosity distribution curves are obtained for the given illuminant. These latter will vary with the illuminant and are often of greater importance than the spectral energy-distribution curves from a visual viewpoint. It is obvious that by multiplying corresponding spectral values the spectral energy-distribution and luminosity distribution curves of any colored medium may be readily obtained for any illuminant.

A number of curves are shown in Fig. 2 which illustrate spectral characteristics of illuminants and colored media and their uses. These are as follows:

I = spectral distribution of energy in the radiation from a Mazda B (vacuum) lamp, operating at 7.9 lumens per watt.

L_i = spectral luminosity-curve of this illuminant. This is found for each wave-length by multiplying the energy value by the visibility of radiation of that wave-length. The visibility of radiation of various wave-lengths has not yet been standardized, but some of the data available, curve V, are satisfactory for many practical purposes.

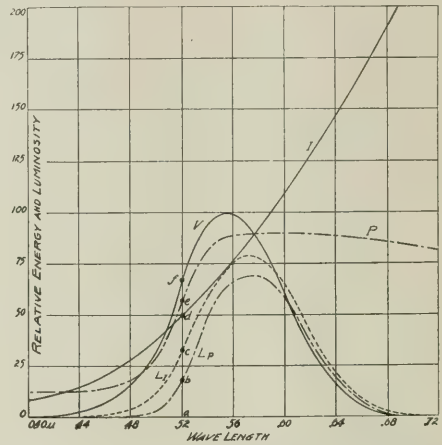

FIG. 2. A STUDY OF A PIGMENT (LIGHT CHROME YELLOW)

P = spectral reflection-factor curve of light chrome-yellow pigment. If the medium were transparent the spectral transmission-factor curve would have been used.

L_p = spectral luminosity curve of the pigment for this illuminant, I. This is obtained by multiplying the ordinates of curve L_i by the corresponding ordinates of curve P.

It should be noted that for most purposes only relative values are necessary but there should be no difficulty in distinguishing between relative and absolute values.

In order to make the procedure clear let us consider wave-length 0.52μ. At this point the relative amount of energy of this wave-length in the illuminant under consideration is indicated by *ad*. The visibility of radiation is indicated by *af*. Multiplying *ad* by *af* gives *ac*, or the relative luminosity of the energy of this wave-length in the illuminant. The reflection-factor of the pigment for energy of this wave-length is indicated by *ae*. Multiplying *ae* by *ac* gives the relative luminosity of the energy of this wave-length reflected by the pigment when illuminated by this particular illuminant. On integrating curves L_i and L_p the relative total luminosities are obtained and by dividing the area L_p

by L_i the reflection-factor of the pigment for this illuminant is obtained. For this particular case the latter value is 82 per cent.

This account has been given in detail in order to illustrate the data which are involved in such an analysis and to illustrate their relations.

The monochromatic colorimeter, which yields data in terms of hue, saturation, and brightness or luminosity, is the most generally analytical among the so-called colorimetric methods. This method analyzes color from the subjective viewpoint and yields data which may be readily visualized by one possessing some experience and an acquaintance with the spectral hues. From a subjective viewpoint the monochromatic colorimeter appears the most feasible method upon which to base a scientific nomenclature of color—an urgent need at present. An advantage of this method lies in relating the analyses to the constant and reproducible visible spectrum; however, in determining the saturation (unity minus the per cent white) a white light is necessary, and this has not been standardized. A further difficulty lies in the unsettled state of color-photometry, which is necessarily involved in determining the luminosity or refraction and transmission factors.

As analyzed by this method, a chrome-yellow might be expressed as having a dominant hue, 0.583μ; a saturation of 75 per cent, or 25 per cent white, and a reflection-factor of 82 per cent.

The trichromatic colorimeter yields analyses in terms of three more or less arbitrarily chosen primary colors; namely, red, green and blue. This is based on a well-known fact of color-mixture; i.e., that any color may be matched in hue by a proper mixture of these three properly chosen primaries. Young built what has later become known as the Young-Helmholz theory of color-vision chiefly upon facts of mixture of these three primaries. This method is not very analytical, and it is quite difficult to visualize a color from an analysis by this method. Furthermore, the data are often misleading to those not thoroughly familiar with their limitations, because the comparisons are made from the subjective standpoint. As an example of the character of the data yielded by this method the colorimeter readings for a chrome-yellow might be: red, 58; green, 37; blue, 5, as compared to a white standard for which the colorimeter readings were 33.3 for the three components.

Besides these chief methods, there are many kinds of colorimeters devised for special purposes—useful in their places, but yielding data of little general value analytically. Some of these are merely tintometers, consisting of a series of tints of various gradients in hue, saturation and reflection (or transmission) factors, designed chiefly for special purposes, such as confining a given product within certain limits as judged by color.

Of the various methods of color-analysis the spectrophotometer is not only the most analytical but its results are definite because standards required are readily available. The lack of standardization of a "white" light and the unsettled state of color-photometry mitigate against the usefulness of the data obtained by the monochromatic and trichromatic colorimeters. There is a need for much standardization in the terminology, notation and analysis of color. However, in color-technology these various methods can be widely applied at present with valuable results.

COLORED MEDIA

For the purpose of this article three classes of colored media will be represented and discussed; namely, pigments, dyes and vitrifiable colors or colored glasses. Pigments are distinguished from dyes by their insolubility in their vehicle, while dyes are soluble. This distinction may appear arbitrary, especially in some cases; however, it is employed to some extent and is a convenient classification. Pigments may be distinguished from paints in that the latter are pigments in a vehicle or medium. Vitrifiable colors are those which impart color to glass and to similar substances. Among pigments are found two general classes: one in which each particle is homogeneous, and the other in which a colorless base has been colored by depositing coloring matter upon it. Colored media vary in many physical characteristics, such as opacity, fineness and refractive index, and they may be considered as varying in "coloring power." However, these facts are of interest only incidentally in this article.

The color of a pigment in a finely divided state, whether the particles are separated by air or by a vehicle, is due to innumerable selective reflections from, and transmissions through, the minute particles. If the powdered pigment is given a smooth surface by pressure it does not appear as pure in color as when it is loosely packed, because in the latter case a greater proportion of the incident radiant energy is able to penetrate more deeply into the body and becomes colored by selective reflections and transmissions. Radiant energy is regularly reflected from even the small surfaces of the particles of pigment, and in those cases where the minute areas of surface are properly oriented this regularly reflected light does not find its way farther into the pigment, but is reflected practically unaltered in spectral character as compared to that energy which penetrates farther into the mass. Thus there is always reflected from pigments some radiant energy which is practically unchanged in spectral character, which accounts partly for the general lack of purity of the colors of pigments. It is seen that the character of the surface is important. Furthermore, the refractive indices of the pigment and of the vehicle (air in the case of dry powders) are of importance, because the amount of light regularly reflected from a surface is dependent upon these refractive indices. A careful study of the influence of the vehicle upon the color of a paint should lead to interesting data from this viewpoint alone. Work has been done in physical optics which is of extreme interest in this connection, but a discussion of it will not be presented here.

Although careful observation will reveal the influence of the porosity of a pigment surface upon its color, an excellent example for the purpose of illustration here is the color of a white cotton fabric compared with that of a white silk fabric after both have been soaked in the same dye solution. Silks are more transparent than cotton fibers; in fact, cotton fibers are merely translucent as compared with the transparency of silk fibers. The latter permit the radiant energy to penetrate more deeply, in general, than the cotton fibers; in other words, the cotton fibres by diffuse reflection turn the

energy backward before it has penetrated very deeply. For this reason the silk fabric appears of a purer color compared with that of the cotton fabric dyed in the same solution, the result, in the case of the silk, being similar to that which would have been obtained with the cotton if the latter had been dyed in a more concentrated solution of the dye.

In a manner similar to the case of pigments the solvent appears to have certain influences upon the color of a solution of a dye, although this subject has not been thoroughly studied. The substance upon which a dye has been deposited by immersion is also of importance in spectral analysis, as is indicated by the case of dyeing cotton and silk fibres. The spectral transmission factor of a dye-solution is a simple logarithmic function of the depth of a given solution or of its concentration, but this relation varies with the wave-length, in general in no definite relation between wave-length and spectral transmission-factor. For this reason no simple relation between total transmission and depth or concentration can be established. Such values of total transmission must be determined by direct measurement or by integration, as already discussed.

Colored glasses can be treated much in the same manner as dye-solutions. A given concentration of coloring material in a glass (that is, a given colored glass) apparently obeys the same law relating to thickness and transmission factor for a given wave-length as a dye-solution. However, it is not established that the introduction of various amounts of the coloring material (generally metallic oxides) results in corresponding concentration, as would be true in the case of dyes. In glass there is more or less chemical action, and the uncertain conditions of melting make this point difficult to decide.

The physics of the process by which glasses are colored by means of metallic compounds is not wholly clear. There are many chemical analogies which are of interest for their parallelism to the colors imparted to glasses by the metals in different states, but the reasons for the appearance of the colors cannot be considered as being thoroughly established. Garnett[3] has presented a very interesting discussion of the colors exhibited by certain glasses in which metallic oxides had been incorporated. It is a common supposition that the colors of certain glasses, such as gold red glasses, are due to the presence of very minute particles of metal. Solutions of some metals exhibit colors which are often exhibited by colored glasses in which the same metals have been introduced. Siedentopf and Szigmondy, by powerfully illuminating specimens of colored glass and colored colloidal solutions of metals obliquely, or at right-angles to the line of sight, were able to detect the presence of the metallic particles. Garnett's work explained some of their observations.

It is commonly considered that metals color glass in two ways: one by being in a state of true solution in the glass, and in the other, by being in a colloidal state. An example of the former is copper blue-green glass, and of the latter, gold red glass.

In dealing with the physics of colored media from the viewpoint of the physicist one cannot avoid the conclusion that there is a wide application of physics to color-technology in many directions quite unexplored; however, such a discussion would be beyond the scope of this article.

PIGMENTS

In Figs. 3 and 4 are shown the spectral reflection-factors of a number of dry powdered pigments.[4] In each case the dry pigment was gently pressed with a plate of glass and the relative amounts of radiation (or light) of various wave-lengths reflected from the thick layer was determined by means of a spectrophotometer. For the sake of simplicity, a surface of a pure white pigment may be used as a comparison standard if its reflection-factors for energy (or light) of various wave-lengths are known. Commercial whites and blacks are not generally strictly neutral pigments, but their selective reflection is difficult to measure except with highly refined apparatus. It is seen from Figs. 3 and 4 that pigments are far from being of high purity as colors. There are so many characteristics of pigments dependent upon simple though intricately interwoven physical phenomena that it is quite beyond the scope of this article to enter into such a discussion.

The direct measurement of the reflection-factor of colored pigments for a given illuminant is uncertain owing to the uncertainties of colorphotometry. Furthermore, owing to the different characteristics of sur-

[3] Phil. Trans. of Roy. Soc., A. vol. 203, p. 385.

[4] Kindly furnished by Sherwin-Williams Co.

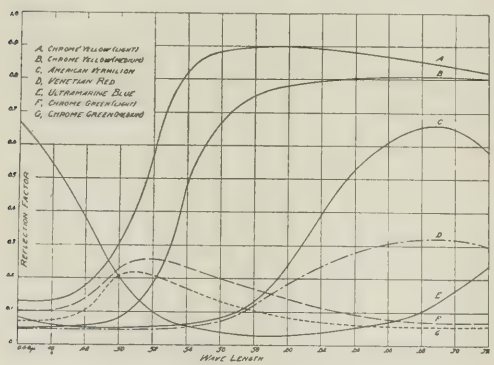

FIG. 3. SPECTRAL REFLECTION-FACTORS OF PIGMENTS

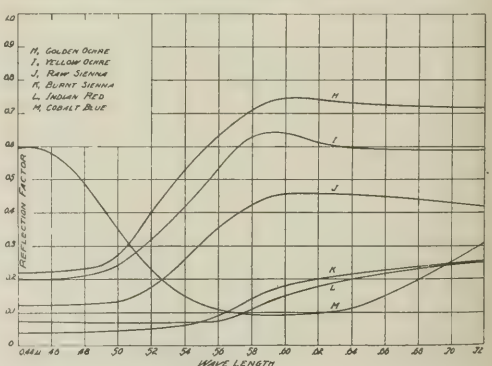

FIG. 4. SPECTRAL REFLECTION-FACTORS OF PIGMENTS

faces, such as dull and varnished, different conditions of illumination and measurement yield different results.[5] Owing to these uncertainties it is recommended that the procedure outlined in the discussion of Fig. 2 be adopted. By this method the reflection-factors for these pigments were determined for several illuminants, the details having been fully described elsewhere (2). In table I are given the reflection-factors for noon sunlight and Mazda B light (7.9 lumens per watt).

TABLE I

	Noon Sunlight	Mazda B
American vermilion	0.14	0.12
Venetian red	.11	.13
Tuscan red	.11	.12
Indian red	.10	.11
Burnt sienna	.11	.13
Raw sienna	.33	.37
Golden ochre	.58	.63
Chrome yellow ochre	.33	.40
Yellow ochre	.49	.53
Chrome yellow (medium)	.55	.63
Chrome yellow (light)	.77	.82
Chrome green (light)	.19	.17
Chrome green (medium)	.14	.12
Cobalt blue	.16	.13
Ultramarine blue	.07	.06
Magnesium oxide	.88	.88
Barium sulphate	.85	.85
Lamp black	.04	.04

Spectral analyses in the ultra-violet and infra-red regions are often of interest in general color-technology. In the former case spectrophotography is the simplest method of attack, although the procedure is a tedious one if high accuracy is desired. It is necessary to establish photographic-density and pigment-illumination (or exposure) relations for various wave-lengths in order to obtain the reflection-factors for radiant energy of various wave-lengths. Besides this, the ordinary precautions of photographic procedure must be taken. Another possible method is that which involves the use of the photo-electric cell. It is well to recognize the importance of such analyses in cases involving ultra-violet light. An excellent example is zinc white, which absorbs ultra-violet energy quite freely.

The investigation of the infra-red region requires a more elaborate apparatus, although in many cases where total energy-absorption is of interest this can be obtained rather easily by means of the thermopile or bolometer. In fact, the ordinary radiometer, or even the thermometer covered with a pigment, yields data which have some uses in practice. Coblentz[6] has published interesting data on the reflection-factors of various substances for infra-red and visible radiation of several wave-lengths. Among the substances which he studied were a number of pigments. The reflection factors of white pigments for energy of wave-length 4.4μ varied from about 0.1 to 0.4, and at 8.8μ and 24μ were considerably lower. These data especially emphasize the localized nature of absorption bands, as, for example, cobalt oxide is a better reflector of long-wave energy than zinc oxide, yet for visible rays it possesses a much lower reflection-factor than zinc oxide. Lead oxide is a much more efficient reflector of long-wave energy than zinc oxide, magnesium carbonate and other white pigments. The importance of the infra-red analyses is apparent in many practical activities. Coblentz has pointed out that a pigment which has a low reflection-factor for energy of wave-lengths in the region of 8μ to 9μ is a better house paint in hot climes, because it reradiates maximally in this region where the maximum radiation from bodies of temperatures from 20 deg. to 25 deg. C. is found. If the paint has a high reflection-factor for visible rays it thus minimizes the heating effect of the incident energy. Such a combination is quite desirable in minimizing the heating effect of solar rays. This is merely one example of a vast number of interesting problems which could be met with more intelligence if spectral analyses were available. There are many aspects such as fading, the effect of the vehicle, the development of paints by mixture, and even the chemistry of pigments in which spectral analyses systematically applied would be of great value.

[5] M. Luckiesh, Electrical World, May 19, 1917.
[6] Bulletin Bureau of Standards, vol. 9, p. 283.

DYES

The mixture of dyes is governed by the same subtractive principles of color-mixture as the mixture of pigments, although the greater number of dyes and the more exacting or delicate applications of dyes in industries, in the making of accurate filters, etc., make their special analyses of perhaps more importance than in the case of pigments. Certainly a knowledge of the spectral characteristics of dyes, as in the case of pigments, makes for an ease and certainty in making and in visualizing mixtures which cannot be enjoyed without such data. A more extended discussion of the usefulness of spectral analyses of dyes has been presented in the more extended paper.[2] There is a vast variety of dyes available, but many are so variable in character that spectral analyses may be only applicable to the particular specimens for which they were obtained. The vast variety of dyes and the sharpness of their absorption bands make it possible to obtain purer and brighter colors from this class of media than from others; however, there are some deplorable aspects such as the rarity of fairly pure blues and violets. Many so-called red dyes transmit deep violet light. There are satisfactory yellows for many purposes, but no yellow dye known to the writer transmits only a narrow spectral region. All of them transmit some green, yellow, orange and red in varying amounts, depending on the concentration of the solution. Among the greens are many dichroics; that is, it is common to find them transmitting deep red light. However, there are excellent yellowish green dyes of fair purity.

By combining various dyes almost any degree of purity of color can be obtained. For example, eosine exhibits a sharp absorption in the yellow region of the spectrum. By combining with this a yellowish green with a sharp cut-off in the orange region, a fairly satisfactory yellow may be obtained. Ethyl violet transmits deep red and deep violet so if it is mixed with an orange such as chrysoidin or a fairly concentrated solution of eosin a deep red is obtained. Similarly, a deep violet may be obtained by mixing a blue-green (which transmits no deep red) with ethyl violet. Of course, the chemistry of the mixtures must be borne in mind, but such mixtures can be made so directly and with predetermined results as to render spectral analyses invaluable. The subtractive principles of color-mixture are applied to the spectral curves in order to predetermine the results.

It has seemed that the aspect of fading could be studied by combining chemical knowledge with the spectral analyses of the dye before and after fading. This

aspect and many others might be more successfully invaded by means of such data. In the testing of the permanency of dyes the spectral characteristic of the illuminant is also of importance, although this is overlooked in most of such work. For example, an illuminant may contain considerable quantities of ultra-violet energy of very short wave-length which may be very destructive although the same rays may never be encountered in practice.

APPLICATIONS OF SPECTRAL ANALYSES OF DYES

The uses for spectral analyses of dyes are manifold, as in the case of any class of colored media. In general they provide a physical basis for systematic color-mixture, besides providing the necessary information for choosing dyes for many purposes. In many aspects of color-technology only the integral or subjective color is finally of interest, but the author cannot refrain from emphasizing that even in such cases an intimate knowledge of colored media and their mixtures cannot be attained without spectral analyses, and that the combination of dyes becomes systematic with such data available.

With spectrophotometric apparatus well maintained, a complete spectral analysis can be made in about an hour, although there is much room for improvement in such apparatus which will result in the saving of time. However, this is not a serious matter, because for a given coloring material only one analysis need be made, as will be shown later, to provide information for all degrees of concentration or depth of solution. The author has available hundreds of spectral analyses which, after once obtained, are a perpetual source of information.

LAWS

In order to simplify the study of coloring media, especially dyes and colored glasses, several simplifications have been made. These are based on theory and have been confirmed by experiment on a few typical specimens. In order to develop this procedure it is necessary to revert to some of the established laws. Lambert first stated that all layers of equal thickness of a transparent medium absorb equal fractions of the radiant energy which enters them. This is true for homogeneous or monochromatic radiation, but cannot be applied to the total absorption of radiant energy of many wave-lengths or of extended spectral character. It follows from Lambert's law that if the thickness of the absorbing medium increases in arithmetical progression the radiation transmitted should decrease in geometrical progression.

It can be proved that,

$$J = J_o e - kd$$

where J_o is the original intensity, J the intensity after traversing a thickness d, and k is a constant depending upon the substance and upon the wave-length of the radiant energy. Various terms have been applied to this factor, for example, absorption-coefficient. In logarithmic form this equation is expressed as:

$$Log \frac{J}{J_o} = log\ T\lambda = -k\lambda\ d\ log\ e = -\Sigma\lambda\ d$$

where $T\lambda$ is the transmission factor for energy of wave-length λ, and the subscripts, λ, indicate the factors which vary with the wave-length. Beer deduced the law that the absorption is the same function of the concentration of a dispersing absorbing substance as of the thickness of a single substance, which may be expressed thus:

$$J = J_o A\lambda^{cd} \text{ or } T\lambda = A\lambda^{cd} \text{ or } log\ T\lambda = cd\ log\ A_\lambda$$

where c is the concentration, A is the transmission coefficient or transmissivity, and the other symbols represent the same factors as in the foregoing equations. The validity of Beer's law has been questioned by some, and it appears that there is some doubt as to its validity in such cases as colloidal solutions. This law appears to hold when the absorbing power of a molecule is uninfluenced by the proximity of other molecules. Obviously, if any change takes place in the condition of the dispersed substance on altering the concentration the law will not hold. Incidentally there is work to be done on the validity of this law in the cases of "colloidal" glasses. Lambert's law appears to be firmly established.

In so far as the foregoing laws are valid (and it appears that this is true for all practical purposes such as described in this article), for a given solution log $T\lambda$ is proportional to d, and for a given depth, or containing cell, log $T\lambda$ is proportional to c. By the use of co-ordinate paper having a logarithmic scale along one axis and a uniform scale along the other a great deal of interesting data can be obtained from one spectral analysis.

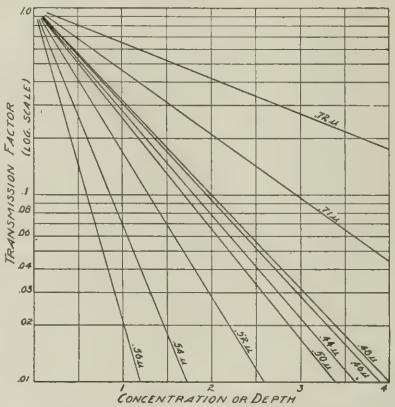

FIG. 5. RELATION BETWEEN SPECTRAL TRANSMISSION-FACTOR AND DEPTH OR CONCENTRATION OF A SOLUTION OF METHYLENGRÜN

By means of the foregoing mathematical relations the spectral analyses of colored solutions (and colored glasses) of any thickness and concentration can be obtained from two determinations of spectral character, which often may be reduced in actual practice to a single determination. Such a method has been found exceedingly practicable in preliminary reconnoitering in search of combinations of dyes for filters, in the development of colored glasses, and in the study of many problems arising in color-technology.

Assume a solution of methylengrün of either known or unknown concentration. A cell of a known thickness is filled with the solution and a spectral analysis is made. For such a purpose a fairly low concentration or small depth is chosen, so that radiations of all wave-lengths which are of interest are appreciably trans-

mitted. On logarithmic paper, as previously described, a plot is made, as shown in Fig. 5, the transmission factors[1] from the spectral analysis being plotted on the logarithmic scale vertically above the arbitrarily selected point on the abscissa axis in this case taken as unity. The abscissæ scale may represent either concentration or depth and may be either a relative or an absolute scale. Straight lines are drawn through the points to a common point on the ordinate axis representing complete transparency or unity on this logarithmic scale. This is the common point if corrections have been made for surface reflections in the cell or from the glass surfaces in the case of a colored glass. If these corrections have not been made, the common point usually will be near 0.92 on the "transmission axis" if two surface reflections must be accounted for. Each straight line represents the relation of log $T\lambda$ and depth or concentration for a certain wave-length. By extending these lines the spectral characteristic of any depth or concentration may be read from the corresponding vertical line. If the original spectral analysis has been made with care, such a simple plot yields a vast amount of data.

Dichromatism.—Methylengrün has been chosen in Fig. 5 because it also illustrates the interesting case of dichromatism so commonly exhibited by dyes. It is seen that the slope of the line for 0.72μ is less than any of the others. This is proof that the dye is adichroic. Some lines are very steep, which indicates a large value of the absorption-coefficient for radiation of these wave-lengths. From the plot it is seen that this dye, in solutions of high concentration or of great depth, will not be green, but will be red.

Similar graphical analyses may be made with relative spectral luminosity values, instead of spectral energy values, but these will not be discussed here. In the former paper (2) the entire relation between transmission factor, wave-length, concentration and depth of solution has been illustrated and discussed.

SPECTRAL ANALYSES OF GLASSES

As in the case of dyes, spectral analyses of colored glasses have many uses in practical developments. Owing to greater difficulties in making mixtures of coloring media in glasses such data are even more welcome in the development of colored glasses. By means of such data these coloring elements can be mixed computationally to obtain the desired spectral characteristic. From very meagre data on the chemical composition from one melt fairly definite strides toward realization may be made in succeeding melts. Of course, there are chemical considerations which sometimes alter the predictions based on computation; however, such a procedure forms a most definite working basis. In the combination of glasses for special filters, lighting effects, etc., the computational method often saves time and provides definite data. Sometimes only the subjective color is desired, but even in these cases spectral analyses of elemental colorings provide the basis for manipulating the available vitrifiable colored media in a manner analogous to the combination of pigments.

In the manufacture of colored glass there is a limited number of coloring materials available, and when the glass must be limited to one general composition, such as soda lime, for example, the colors which are possible of attainment are further limited. However, by combining various coloring materials the variety of colored glasses can be enormously extended to meet the requirements of science and art.

It is beyond the scope of this article to present spectral analyses of glasses, but these may be found in references given and elsewhere, but the importance of such data cannot be overemphasized.

USES OF SPECTRAL ANALYSES OF GLASSES

The applications for spectral analyses of colored glasses have been fairly well covered in the discussions of pigments and dyes, for the same general procedures can be applied to colored glasses. The concentration is not so definite as in the case of dyes, because, owing to the high temperature at which glass melts and to chemical action, the concentration of coloring material in the final glass cannot always be predicted from the amount of the coloring metal added to the mix. Some of the metals, such as cobalt and copper, under standardized conditions of melting, appear to produce concentrations of coloring material proportional to the amounts of the oxides added to the mix, but in some cases there is doubt as to this proportionality. There is need for systematic study in this direction. In the case of the red glasses, for example, gold ruby, which in ordinary manufacture assumes its red color on reheating, the manipulation has considerable effect upon the density of the color. After a colored glass has been obtained it is possible to procure from a single spectral analysis the integral transmission factor for any illuminant, the spectral characteristics of other thicknesses, and those of combinations of these thicknesses with other colored glasses as already outlined.

In developing a colored glass for a specific purpose various factors are considered, such as the illuminant to be used and the result to be obtained. From these an ideal spectral transmission curve is determined, and by means of a few spectral analyses of different colored glasses, bearing in mind the chemical considerations if a mixture is finally necessary, various combinations can be made with the aid of the graphical method.

Often the ultra-violet and infra-red spectral transmissions are of interest, and these are made in the manner already described. The data on a coloring element are not considered to be sufficiently complete for record if the ultra-violet transmission is not studied at least qualitatively, and in some cases the infra-red transmission is investigated.

National Lamp Works of General Electric Company,
Nela Park, Cleveland, Ohio.

[1] Note.—Transmission factor is defined by the Illuminating Engineering Society as the ratio of the transmitted to the incident flux. In the present use the surface reflections are eliminated in order to make the data more useful, so that the same definition applies here for the given thickness if the body is assumed to be immersed in medium of the same refractive index.

The market for bauxite in the United States is east of Mississippi River, and the largest consumers are located at or near the following cities: East St. Louis and Aurora, Ill.; Detroit, Mich.; Cincinnati, Ohio; Knoxville, Tenn.; Philadelphia and Erie, Pa.; Niagara Falls and New York City, N. Y.; and Boston, Mass. Recently a number of municipal and industrial waterworks have installed small plants for the manufacture of aluminum sulphate for use in purification of water. It is not believed that this new market will materially affect the industry, as it seems probable that its demands will not be great.

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Laboratory Methods for Benzol-Recovery Plant Operation—III

By F. W. Sperr, Jr.
Chief Chemist, H. Koppers Co.
(*Concluded from Page 588*)

Method for Determining the Specific Gravity of Benzols

For routine purposes the test is made by means of a Westphal balance.

Cool the oil to about 12 deg. C., rinse out the cylinder with a portion of the oil; suspend the plummet from the balance into the cylinder, and fill the latter with the cold oil. When the temperature, as shown by the plummet thermometer, is almost 15.5 deg. C., place weights on the beam and adjust rapidly at 15.5 deg. C. The specific gravity may also be determined by the pyknometer, but extra precautions have to be taken on account of the high coefficient of expansion of the benzols.

Sulphuric Acid Color Test for Benzol, Toluol, Solvent Naphtha, Etc.[1]

The set of color standards consists of fifteen sealed tubes, approximately 1 in. diameter, each containing one of the solutions made up as given below.

When making a test for amount of acid washing, a glass-stoppered weighing bottle about 1 in. diameter and 2 ½ in. high is used (E. H. Sargent No. 802[2]). One cc. of concentrated (1.84 sp. gr.) sulphuric acid is put in first and then approximately 21 cc. of the material to be tested is added. Shake thoroughly for 15 to 20 sec., and allow to stand for specified time. Compare the resulting color of the acid layer with the standard set, and determine to which number it corresponds.

In pure benzol and pure toluol testing, the benzol or toluol layer must remain white, and the color of the acid layer, after standing 15 min., must not be darker than No. 4.

[1]Gas Chemists Handbook, p. 187.

[2]One ounce glass stoppered "French Squares" are usually prescribed. We have found the round bottles with straight sides easier to clean.

For 90 per cent benzol and all grades of benzol and toluol other than pure, the benzol and toluol layer must remain white and the color of the acid layer, after standing 15 min., must not be darker than No. 6.

For solvent naphtha the acid layer color only is noted. After 5 min. standing it must no tbe darker than No. 14.

In making the test it is customary to take the color of the main portion of the acid, and should a darker ring form—just below the benzol or toluol—this is disregarded.

The solutions for the standards are made up as follows: The following basic solutions are used:

A. 59.4965 gr. $CoCl_2\ 6H_2O$ (nickel free) is made up to 1000 cc. with a mixture of 25 cc. 31 per cent HCl and 975 cc. H_2O.
B. 45.054 gr. $FeCl_3\ 6H_2O$ made up to 1000 cc. with a mixture of 25 cc. 31 per cent HCl and 975 cc. H_2O.
C. 3.5 volumes of solution A + 36.5 volumes solution B + 90 volumes of H_2O.
D. 3.5 volumes of solution A + 36.5 volumes of solution B (no water is added).
E. Solution of K_2CrO_4 saturated at 21 deg. C.
F. 1 volume of a solution of $K_2Cr_2O_7$ saturated at 21 deg. C. + 1 volume of H_2O.

As standard color solutions to be used for comparison the following are made up and numbered from 0 to 14.

No. 0. Pure water.
No. 1. 1 volume of solution C + 1 volume of H_2O.
No. 2. 5½ volumes of solution C + 2 volumes of H_2O.
No. 3. Solution C as such.
No. 4. 1 volume of solution D + 1 volume of H_2O.
No. 5. 5½ volumes of solution D + 2 volumes of H_2O.
No. 6. Solution D as such.
No. 7. 5 volumes of solution E + 2 volumes of H_2O.
No. 8. Solution E as such.
No. 9. 7 volumes of solution E + ½ volume of solution F.
No. 10. 6½ volumes of solution E + 1 volume of solution F.
No. 11. 5½ volumes of solution E + 2 volumes of solution F.
No. 12. 1 volume of solution E + 1 volume of solution F.
No. 13. 2 volumes of solution E + 5 volumes of solution F.
No. 14. Solution F as such.

Tests of Washed Benzol

These tests are made on samples of benzol from the agitator, which is used for the sulphuric acid treatment of the crude distillates. The object of the test is to determine whether a sufficient degree of purification has been attained by the acid treatment.

WASH TEST FOR BENZOL AND TOLUOL

It is presumed that the benzol or toluol or mixture of both has been agitated with sulphuric acid and the latter removed after the customary settling. Transfer about 350 cc. of the sample into a 500-cc. separatory

funnel; add about 30 cc. tap water; shake about 30 sec. and allow to settle. Drain off water and impurities. Add about 30 cc. of a 1.10 sp. gr. solution of NaOH (95 grams per liter), agitate about 50 sec. or until the mixture develops a yellowish color. Let settle and drain off soda and impurities. Add about 30 cc. of tap water; agitate about 30 sec.; let settle and drain off water, leaving the completely washed benzol and toluol in the funnel. Add between 5 and 10 grams of fused $CaCl_2$, agitate for a few seconds, and allow to settle until the oil clears. Transfer through the mouth of the funnel about 60 cc. of the oil into a clean 100-cc. distillation flask, previously rinsing flask with the same oil, exercising care to prevent benzol from getting into the side neck of the flask. Connect to a clean condenser and distil to about 80 deg. C., catching distillate in a clean test tube. Quickly reject this distillate from the test tube and continue distillation to 95 deg. C. in case of benzol or to 115 deg. C. in case of toluol or a mixture of benzol and toluol. The sulphuric acid color test is then made on a portion of the distillate as described in the preceding test. Care must be taken to test each lot of $CaCl_2$ for impurities that might affect the results.

WASH TEST FOR SOLVENT NAPHTHA

It is presumed that the solvent naphtha has been agitated with sulphuric acid; has been allowed to settle, and separated. Transfer about 350 cc. to a 500-cc. separatory funnel; add about 25 grams of CaO (pulverized). Shake about 1 min. and allow to settle. Rinse a clean 100-cc. distilling flask with a portion of the solvent and distil 60 cc. to 180 deg. C., using a clean condenser and test tube for the distillate. The sulphuric acid color test is then made on a portion of the distillate as described above.

Test for Sulphur Dioxide and Sulphur Trioxide in Washed Benzols

Place the oil to be tested in a bottle, filling the bottle not more than half. Cork and shake well; then uncork and quickly place a piece of moist test paper in the mouth of the bottle, holding by the fingers or by carefully replacing the cork. The paper must in any case be exposed to the vapors above the oil. The test is quite sensitive and color change will be noted almost immediately if SO_2 or SO_3 are present. The test paper will change from a yellow to a red if SO_2 or SO_3 are present.

ALTERNATE METHOD

This test can very conveniently be made in connection with the test for completeness of washing with acid. Before distillation of the washed light oil is made, place an adapter on the end of the condenser, and place a piece of the moist test paper in the top of the adapter in such a manner that the paper is exposed to the vapors, but not to the stream of condensed liquid. The moist paper will adhere quite readily to the walls of the adapter. Continue with distillation and note color change if SO_2 or SO_3 are present.

To Make Test Papers—Make a solution of methyl orange by placing 0.1 gm. of it in 100 cc. water, shaking it at intervals and finally allowing to stand over night. Finally filter off any solid matter and use the clear liquid for making test papers. Cut up filter paper into narrow strips (paper free from sulphites and acids should be used) and dip into the methyl orange solution. Shake off excess solution, as the test gives best results with moist paper, i.e., paper that has no drops of excess solution adhering to it.

Approximate Determination of Unsaturated Compounds in Washed Benzol by Bromine Titration[3]

A measure of the quantity of unsaturated compounds (hydrocarbons of the ethylene and acetylene series, etc.) present in crude benzol is afforded by titration with bromine. The bromine water formerly used for this purpose is best replaced by a solution of potassium bromide and bromate, which, on addition of sulphuric acid, sets free 8.0 gr. of bromine per liter. The test is carried out by Frank in the following manner:

5 cc. of the sample are added to 10 cc. of dilute sulphuric acid (1:5) contained in a 50-cc. bottle provided with a glass stopper, and N/10 bromine bromate solution containing 9.9167 gr. $KBr + 2.7833$ gr. $KBrO_3$ per liter is added from a burette until, after 5 minutes' shaking, bromine still remains. The titration is finished when the floating oil remains orange-red in color after standing for 15 minutes, and when one drop gives a dark blue coloration with freshly prepared potassium iodide starch paper. The quantity of bromine used (1 cc. = 0.008 gr. Br) should be reported as grams Br per 100 cc. of sample. To obtain accurate results, a preliminary determination is first made, and then two exact estimations, the mean of which is taken. Pure benzene and pure toluene should show a marked bromine reaction after the addition of 0.1 cc. of the bromine solution; whilst 90 and 50 per cent benzols will decolorize on an average 0.6 cc. of the reagent, but seldom more than 1 cc. Commercial xylene absorbs 2 per cent bromine in a few minutes and considerably more on standing for some time.

Freezing Point Test of Benzene

The thermometer used is a so-called "titer test" thermometer, graduated to tenths of a degree from 0 deg. to 65 deg. C., and is about 15 in. long. Those in use at present are made by the Taylor Instrument Company, Catalog No. 1425. They should be standardized against the freezing point of water. About 40 cc. of pure benzene is placed in a tube or short cylinder—preferably a titer cylinder, of about 1¼-in. diameter and about 3½ in. high, made of rather thin glass. This is placed in a bath of ice water, and a small amount of salt added. The bath temperature should be about 0 deg. C.

Suspend thermometer in the benzene, stirring constantly. When temperature remains constant about 30 seconds (care must be exercised here not to greatly supercool the benzene; however, with stirring, there is not so much danger of this) allow thermometer to stand with the bulb in the center of the benzene, and allow the mercury to rise. The highest point is the freezing point.

The following comparisons will show the relative sensitiveness of the freezing point and boiling point tests. First samples of pure benzene were tested by the boiling point and freezing point tests with the following results:

[3]Method of Kraemer and Spilker. Muspratt's Encyclopaedia (1905 German Ed.), Vol. 8, p. 33—et seq.

	1 Deg. C.	2 Deg. C.	3 Deg. C.	4 Deg. C.
1 drop	80.15	79.63	79.68	78.72
5 cc.	80.25	80.13	80.06	79.45
10 cc.	80.32	80.21	80.16	79.67
20 cc.	80.35	80.28	80.24	79.92
30 cc.	80.35	80.35	80.31	80.09
40 cc.	80.36	80.39	80.36	80.22
50 cc.	80.36	80.42	80.36	80.27
60 cc.	80.37	80.43	80.36	80.32
70 cc.	80.37	80.47	80.36	80.37
80 cc.	80.38	80.53	80.41	80.42
90 cc.	80.42	80.58	80.46	80.47
95 cc.	80.45	80.68	80.53	80.52
Dry	80.47	80.93	80.61	80.72
Freezing point	5.13	5.15	5.15	4.70

To show the relative effects of small amounts of impurities, comparisons were made on samples of pure benzene to which 0.5 per cent of toluol, petroleum ether and carbon disulphide had been added with the following results.

Portions of sample No. 1 (above) were used.

	Benzene, 99.5% Toluol, 0.5% Deg. C.	Benzene, 99.5% Petroleum Ether, 0.5% Deg. C.	Benzene, 99.5% Carbon Disulphide, 0.5% Deg. C.
1 drop	80.23	79.59	79.18
5 cc.	80.53	80.11	79.68
10 cc.	80.54	80.30	79.88
20 cc.	80.58	80.48	80.08
30 cc.	80.64	80.49	80.18
40 cc.	80.66	80.49	80.26
50 cc.	80.68	80.57	80.34
60 cc.	80.72	80.58	80.41
70 cc.	80.74	80.59	80.43
80 cc.	80.77	80.62	80.45
90 cc.	80.94	80.62	80.48
95 cc.	81.83	80.62	80.48
Dry.	83.35	80.63	80.53
Freezing point	5.2	5.3	5.0

Evaporation Test of Benzols[1]

2 cc. of the benzol are placed on a metal surface with raised edges 3.5 in. square, and the time taken for complete evaporation is noted. In order to allow for variation in temperature this should be compared with pure benzene, which requires 10 minutes for complete evaporation at ordinary laboratory temperatures.

Method for the Determination of Carbon Disulphide in Benzols[2]

Fifty grams of the benzol are mixed with 50 gr. of a solution of potassium hydroxide and absolute alcohol (11 gr. potassium hydroxide and 90 gr. absolute alcohol). The mixture is shaken and allowed to stand several hours at room temperature. About 100 cc. of water are then added. The aqueous solution is separated from the benzol and the latter is washed several times with water. The washings are added to the aqueous solution. The potassium thiocarbonate is determined either in the solution directly or in an aliquot part of the same, by means of a solution containing 12.475 gr. crystallized copper sulphate per liter. One cubic centimeter of this solution is equivalent to 0.0076 grams of carbon disulphide. The aqueous solution is neutralized with acetic acid and the standard copper solution is added until a drop of the solution put on a piece of filter paper, by means of a glass rod, shows a red color when brought in contact with a drop of potassium ferrocyanide. The approach of the end point is made known by a certain agglomeration of the finally divided precipitate of copper thiocarbonate.

The amount of potassium hydroxide solution given above is sufficient for a benzol containing 5 per cent carbon disulphide, but for larger percentages of carbon disulphide the quantity of potassium hydroxide must be increased, or else a smaller sample of benzol must be taken.

It is important to run a careful blank on the reagents used.

Determination of Hydrogen Sulphide in Light Oil

Place 50 cc. of the light oil in a separatory funnel, and shake thoroughly with a mixture of 20 cc. normal sodium hydroxide solution and 50 cc. of water. After shaking, let the layer separate and draw off the aqueous layer. Wash the light oil again by shaking two or three times with water, separating the aqueous layer each time. Unite the aqueous extracts; dilute to 300 or 400 cc.; add dilute HCl in excess and titrate with N/10 iodine solution, using starch as an indicator. One cubic centimeter N/10 iodine is equivalent to 0.0017 gr. H_2S.

Specifications and Tests of Wash Oil Used for Benzol Recovery

1. Specific gravity at 15 deg. C. must not be over 0.880.

2. The viscosity must not be more than 92 seconds at 21 deg. C., and must not be more than 150 seconds at 4 deg. C., both tests to be made in a Saybolt viscosimeter. No solid matter must separate at 4 deg. C.

3. At least 95 per cent of pure oil should separate from the water in 10 minutes, and the oil should not contain more than 0.5 per cent water in the separated oil when the following test is made.

Twenty cubic centimeters distilled water and then 100 cc. of the oil are placed in a graduated 250-cc. cylinder. Steam is bubbled through the two liquids by means of a glass tube whose inside diameter is approximately 3/16 in. After steaming 10 minutes, the cylinder and its contents are placed in a water bath at 15 deg. C. for 10 minutes, and the volume of separated oil is read. To determine the amount of pure oil separated and water content of the separated oil, draw off the oil by means of a pipette, taking care to get none of the water layer; shake the oil thoroughly; take 20 cc. and mix with 80 cc. pure solvent naphtha in a graduated precipitating tube having the lower end drawn out and graduated 1/10 of 1 cc. This oil-solvent naphtha mixture is kept at a temperature of not over 80 deg. F. for one hour, or the mixture may be separated by means of a centrifuge. The amount of water separated is then read.

4. The oil must not contain more than 12 per cent olefines as determined by the following test:

The apparatus consists of a glass-stoppered flask having a 100-cc. mark at the bottom of the neck and a 110-cc. mark at the top of the neck. (This is listed as a "Cassia flask" by most dealers in chemical apparatus.) The space between these two marks is divided into 1/5 cc. or 1/10 cc. Special sulphuric acid is prepared by mixing one part of fuming sulphuric acid (containing 25 per cent SO_3) with two parts of concentrated sulphuric acid containing 93 per cent H_2SO_4.

Ten cubic centimeters of the wash oil are exactly measured by a burette into the 100-cc. graduated flask and shaken vigorously with 25 cc. of the special acid. After standing for one hour, fill the flask to the 110-cc.

[1] Jour. Ind. and Eng. Chem., Vol. 3, p. 11.
[2] A. Spilker, Kokerei und Teerprodukte der Steinkohle

mark with concentrated sulphuric acid. The acid should be added by pouring it slowly against the neck of the flask in order to avoid agitating the already settled mixture. Allow the mixture to stand for two hours and then read the amount of the paraffins left. The difference gives the amount of olefines in the original 10 cc. of oil.

5. Not more than 5 per cent of the oil should distil under 250 deg. C., and an additional 85 per cent should distil within 120 deg.

NOTES ON SPECIFICATION TESTS

Specific Gravity: The test is made with a Westphal balance. In setting up the balance, the screw in the base of the balance is adjusted so that the two pointer protuberances are exactly on the same level when the thermometer is suspended at the end of the beam. The height of the beam can be regulated by the screw in the vertical support so that the plummet does not touch the bottom of the glass cylinder. The weights consist of four sizes. The largest size hung on the hook at the end of the beam gives units; on any other space gives tenths; the next size indicates hundredths; the next thousandths, and the smallest ten-thousandths of specific gravity.

After cooling a sample of the oil to about 10 deg. C., the cylinder is rinsed with the oil; the suspended plummet inserted in the cylinder, which is filled with the cooled oil. The weights are placed on the various divisions and so adjusted that when the thermometer indicates 15.5 deg. C., the two pointer protuberances are on the same level. (After the specific gravity figure is obtained, the plummet and cylinder are rinsed with benzol.)

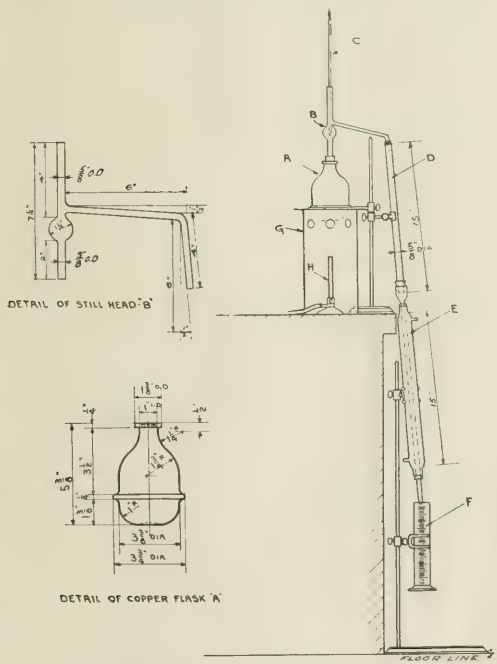

FIG. 6—APPARATUS FOR DISTILLATION OF STRAW OIL

A. 500 cc. copper flask (Elmer & Amend, 3018—E. H. Sargent No. 1938.)
B. Still head.
C. 400 deg. C. thermometer.
D. Glass Air condenser.
E. 15-in. Liebig condenser.
F. 100 cc. graduate.
G. Asbestos or sheet iron shield.
H. Standard Bunsen or Tecla burner.

Distillation: The distillation is made in the apparatus described in Fig. 6, using 200 cc. of the oil as a sample. The temperature is recorded for the following quantities of distillate.

	First Drop
10 cc.	5 per cent
20	10
40	20
60	30
80	40
100	50
120	60
140	70
160	80
180	90

Olefines: The special acid, equivalent to two parts 93 per cent H_2SO_4 and one part of fuming sulphuric acid containing 25 per cent free SO_3 by volume, may be prepared from acid of their strengths according to the following method:

According to Van Nostrand's "Chemical Annual," 93 per cent H_2SO_4 contains 1393 gr. SO_3 per liter. The 25 per cent fuming sulphuric acid contains 86.22 per cent total SO_3. Calculation shows that the acid required contains 1485 gr. SO_3 per liter. An example will illustrate the calculations necessary to prepare this acid.

To make up 1000 cc. H_2SO_4 containing 1485 gr. per liter of SO_3 from 95 per cent (conc.) H_2SO_4 and fuming H_2SO_4 (15 per cent free SO_3).

Then: Let X = number of cubic centimeters of 95 per cent acid required

$1000 - X$ = number of cubic centimeters of 15 per cent free SO_3 acid required

Total SO_3 in X cc. of 95 per cent H_2SO_4 = 1.426 X gr.

15 per cent fuming acid contains 84.39 per cent total SO_3

Specific gravity of 15 per cent fuming acid is 1.918

SO_3 in $(1000 - X)$ cc. of 15 per cent fuming H_2SO_4 = $0.8439 \times 1.918\ (1000 - X)$ gr.

$1.426\ X + 0.8439 \times 1.918\ (1000 - X) = 1485$

X = 696 cc. 95 per cent (conc.) H_2SO_4

$1000 - X$ = 304 cc. 15 per cent free SO_3 fuming H_2SO_4.

The Determination of Light Oil in Benzolized and Debenzolized Wash Oil

BENZOLIZED WASH OIL

One liter of the benzolized oil is transferred to a ½-gallon copper still. The still is connected to a 15-in. condenser leading into a 500-cc. separatory funnel described in method for "Determination of Light Oil in Gas." (Fig. 2.) The oil is heated to about 140 deg. C. with a burner, and live steam is then conducted through the oil at such a rate that the distillate comes over quite rapidly, but not in a continuous stream. Unusual care

should be taken to attach the cover to the top of the still in such a way that the latter does not leak. The presence of a leak, no matter how slight, will produce false results. The lid, provided with a firm cardboard gasket, should be fastened on as tightly as possible, and the space between the edge of the lid and the thread of the still should be wrapped tightly with asbestos cord. This wrapping of asbestos cord can be made absolutely vapor-tight by cementing with sodium silicate; but this is not always necessary.

The oil should be submitted to the steam distillation until one liter of water is condensed in the funnel. The distillate of oil in the funnel is then drained free of water and is agitated with about 10 cc. of a saturated solution of $CaCl_2$, which is finally drawn off. The inside of the stem of the funnel is wiped thoroughly dry by means of a pellet of raw cotton and the oil distillate is transferred to a 100-cc. flask (Fig. 3), in which it is dry distilled to 200 deg. C., the distillate being received in a graduated test tube.

$$\frac{\text{No. cc. of distillate up to 200 deg. C.} \times 100}{1000} =$$

per cent light oil in the benzolized absorbent oil.

DEBENZOLIZED WASH OIL

The procedure is similar as with the benzolized wash oil, with the exceptions that a sample of six to eight liters is used. This is distilled in a similar still, and the distillation is considered complete when two liter of water have condensed in the separatory funnel.

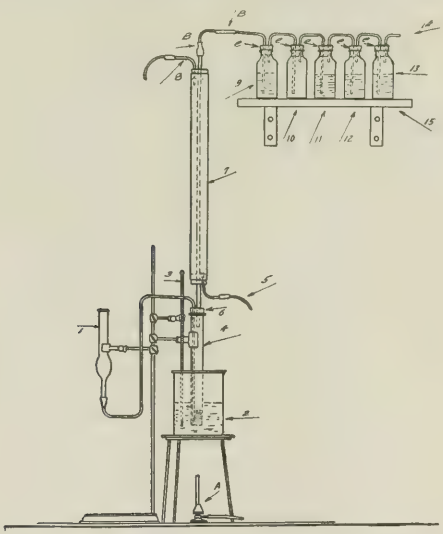

FIG. 7—APPARATUS FOR THE DETERMINATION OF NAPHTHALENE IN OILS

1. Guard Tube 4 in. to 6 in. connected.
2. 600 cc. Beaker.
3. Thermometer.
4. Flat bottomed test tube, 8 in. x 1 in.
5. Water inlet.
6. 2-hole rubber stopper.
7. Condenser.
8. Water outlet.
9. $\frac{N}{1}$—Sulphuric Acid.
10. Empty bottle.
11. 150 cc. sat. picric acid sol.
12. 150 cc. sat. picric acid sol.
13. 150 cc. sat. picric acid sol.
14. Connection to suction.
15. Shelf.

B. Rubber connection.
A. Bunsen burner.

Determination of Naphthalene in Oils[6]

The apparatus is shown in the accompanying sketch (Fig. 7).

The sample, about 10 gr. (the quantity depending upon the approximate naphthalene content[7]) is accurately weighed and placed in the test tube 4 which is an 8-in. by 1-in. flat-bottom test tube. 1 is a 6-in. calcium chloride tube (empty) which serves as a guard, connected as shown by glass tubing through the two-holed rubber stopper (6), practically to the bottom of the flat-bottom test tube. The guard tube serves as a safety device in case the oil is blown out. It also serves as the air inlet for the air which passes through the oil and carries out the naphthalene. 7 is a water-jacketed condenser having an 18-in. water jacket and an inner tube 12 mm. This conveys over the air with the naphthalene but returns the oil to the test tube. 5 is the water inlet and 8 is the outlet. 9 is a wide mouth salt bottle containing about 200 cc. N/1 sulphuric acid. This bottle will trap any tarry or alkaline substances. 10 is an empty bottle serving as a trap for any solvent carried over. 11, 12 and 13 are wide-mouthed salt bottles fitted with two-holed rubber stoppers, each containing 150 cc. of a saturated solution of picric acid. 14 is the connection to suction.

The sample is placed into the test tube (4) and the apparatus connected and the suction turned on so that air bubbles through the oil at about 1½ cu. ft. per hour. Water is turned on in the condenser. The burner is placed under the beaker containing the water and heated slowly until the water boils, and then is continued for one hour. Then the flame is turned out and the air is allowed to bubble over night.

PREPARATION OF THE BENZOL SOLUTION OF NAPHTHALENE PICRATE

Transfer the picric acid solution and the precipitate to a liter separatory funnel, the residues being washed in with naphthalene free benzol. Shake gently the contents of the funnel until the precipitate is completely dissolved in the benzol. Reject the aqueous layer and draw the benzol solution into a 250 cc. measuring flask. Make up to the mark with benzol and thoroughly mix.

DETERMINATION OF THE TOTAL PICRIC ACID

Titrate 50 cc. of this solution—preferably in a 200-250-cc. separatory funnel, for shaking is necessary—with N/5 NaOH, using methyl red as the indicator. This titrates both the free and the combined picric acid.

If T = cubic centimeters N/5 NaOH required for this total titre

Then 5T = cubic centimeters N/5 NaOH required for the total titre of the whole solution.

(To prepare methyl red indicator dissolve 2 gr. methyl red in 1 liter of a mixture of two parts grain alcohol and one part water.)

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[6] Adapted from the method for Naphthalene in Gas, Gas Chemists Handbook, 1916.

[7] Enough naphthalene should be present to saturate the picric acid in the first absorption bottle. This is important for obtaining accurate results. When too little naphthalene is present the results will tend to be too high. In such cases we have found it desirable to add a measured volume of benzol containing a known amount of naphthalene to the solution in the 250cc flask before making up to the mark. This is readily corrected for in the final result.

DETERMINATION OF THE FREE PICRIC ACID

The free picric acid present is determined by the following procedure:

From a burette draw $\frac{T}{1200}$ cc. of the benzol solution into a 100-cc. flask and evaporate to dryness to remove the benzol, proceeding carefully according to the following directions. The flask is placed in hot water bath, and a current of air passed over (not in) the benzol solution, at no time allowing the level of the hot water to be above the level of the benzol solution. The flask should be gently shaken during the evaporation to keep the walls moist and to avoid overheating any part. Keep the flask about one minute in the hot water after the residue appears dry, then remove, but continue the air current until the odor of benzol can no longer be detected.

Dissolve the residue in the flask with 10 cc. of 95 per cent alcohol, heating gently if necessary, then precipitate the naphthalene picrate with distilled water, adding it slowly with agitation until the volume is 100 cc. The temperature of this solution must be cooled to 20 deg. C. In no case more than 2 deg. higher or lower.

Filter through a dry filter into a 100-cc. cylinder and titrate 90 cc. of the filtrate with N/5 NaOH, using methyl red as the indicator.

The cubic centimeters of N/5 NaOH taken divided by 0.9 gives the titre required for the free acid (picric) in $\frac{1200}{T}$ cc. of the original benzol solution.

If F = cubic centimeters N/5 NaOH required for this $\frac{1200}{T}$ cc.

Then $F \times \frac{250}{\frac{1200}{T}}$ = NaOH required for the free picric acid in the whole benzol solution.

CALCULATION FOR THE NAPHTHALENE FROM THE PICRIC ACID TITRES

The difference between the total titre and the free acid titre is the titre of the picric acid combined as naphthalene picrate, and this latter titre multiplied by its naphthalene equivalent gives the grams naphthalene in the sample.

Total titre — Free acid titre; Grams naphthalene equivalent to 1 cc. N/5 NaOH

$$\left\{ 5T - F \times \frac{250}{\frac{1200}{T}} \right\} \times 0.0256 = \text{grams naphthalene in the sample.}$$

or, simplified:

$0.0053T\ (24 - F)$ = grams naphthalene in sample.

and $\frac{0.0053T\ (24 - F)}{\text{grams of sample}} \times 100$ = per cent naphthalene.

NOTES ON THE METHOD

The reactions involved in the method are the following: Naphthalene combines with picric acid to form naphthalene picrate according to the following quotation:

$$C_{10}H_8 + C_6H_2(NO_2)_3OH = C_6H_2(NO_2)_3OHC_{10}H_8 + H_2O$$

$$\underset{C_6H_2(NO_2)_3OH}{\text{Picric Acid}} + NaOH = \underset{C_6H_2(NO_2)_3ONa}{\text{Sodium Picrate}} + H_2O$$

$$C_6H_2(NO_2)_3OH.C_{10}H_8 + NaOH = C_6H_2(NO_2)_3ONa + C_{10}H_8 + H_2O$$

To absorb the naphthalene completely the picric acid solution must be fully saturated, and to insure this an excess of crystals must be present. The reason for taking $\frac{1200}{T}$ of the benzol solution for the free picric acid test is that this is the quantity which contains the right amount of picric acid (1.1 gr.) to saturate the 100 cc. of solution to which it is finally made up, and this saturation is essential to prevent decomposition of the naphthalene picrate present at the stated temperature (20 deg. C.). Naphthalene picrate is easily decomposed by heat, evolving naphthalene and leaving behind free picric acid. A blank should be run on the reagents, using a weighed amount (about 0.1 gr.) of pure naphthalene dissolved in the 250 cc. of benzol.

The Future of Electrolytic Zinc*

By Thomas French

In the last two years a large quantity of high-grade electrolytic zinc has been produced in the United States and Canada, and at the present time many other plants are projected. In view of this rapid progress the question has often been asked: Will the older retort process of smelting be superseded by the electrolytic deposition of zinc?

The reply to this question is generally given in an unqualified negative, apparently justified by the rather unsatisfactory recoveries of zinc obtained by those who have adopted the electrolytic process. The poor recovery is attributed mainly to the difficulty of roasting the ore without the formation of ferrite of zinc, which is very difficult to dissolve in the acid effluent from the electrolytic vats, but also to the difficulty in dealing with the filtration of slimy acid and neutral solutions.

We hear of great variations in the amount of zinc that can be dissolved from the roasted ore. Sometimes a 90 per cent extraction of the zinc in the ore is obtained, and at other times only half, or even less than that amount, from the same ore. The average recovery of zinc appears to be less than 70 per cent by most of those engaged in the manufacture of electrolytic zinc from ores or concentrates containing about 40 per cent zinc.

If an extraction of 90 per cent of the zinc can at times be obtained, and at other times cannot be obtained from the same ore, then assuredly, sooner or later, the reason for the disparity will be found. That being so, and taking into consideration several weighty factors favoring the electrolytic process for the reduction of zinc from its ores, there is more than a strong probability that the retort process for the reduction of zinc is doomed in the near future.

*A paper presented at the Pittsburgh meeting of the American Electrochemical Society, Oct. 3, 1917.

In forming this opinion, one of the chief considerations is that electrolytic zinc is being produced either by lead or copper manufacturers, and may be considered to be a by-product. It is true that some of these manufacturers are treating customs ores, but this is only to take advantage of the very profitable price of zinc which has ruled for some time, and to fulfill large contracts. The primary reason for the erection of these electrolytic plants was to extract from their own ores the zinc which previously had either been wasted or not worked at all.

In the case of the lead smelter, especially those whose ores contain much zinc, it is imperative that the zinc should be extracted, in order that the lead may be profitably smelted. Before long a modern lead smeltery will not be considered complete without the adjunct of an electrolytic zinc reduction plant, if it is within reach of electric power at a reasonable rate. The competition of this by-product zinc will itself seriously affect the output of the retort smelters.

With proper adjustment of the roasting furnace conditions, it is not a difficult matter to obtain extractions of 90 per cent from ores containing 15 per cent to 25 per cent zinc, and in the latter case with as much as 25 per cent of iron. As far as the author's experience goes, furnaces of the Wedge and Herreshoff type are admirably adapted to the roasting of this class of ore. A large Wedge furnace, with seven hearths and a diameter of 22 ft. 6 in. is capable of roasting about 1¼ tons of this ore per hour, with unskilled labor, and gives a more satisfactory product than the smaller handrabbled furnaces. After roasting concentrates containing 45 per cent zinc, there is little difficulty in extracting as much as 95 per cent to 97 per cent of the zinc.

The successful electrolysis of zinc from sulphate solutions has not been an easy matter, and it is only within recent years that the difficult problem of depositing high-grade zinc has been satisfactorily accomplished on a commercial scale. The principal requisite is that the electrolyte shall be quite free from certain impurities. The methods by which freedom from these impurities is assured are now very well understood, and with experienced superintendence there is little difficulty in obtaining a high efficiency in that part of the process.

When certain underlying principles are recognized, the difficulty encountered in dealing with the filtration of the acid and slimy solutions also largely disappears, although it has been a very serious one to the uninitiated. In the dissolving of the zinc from the roasted ore there is nothing which any competent chemical engineer can not undertake, and any other operations connected with the electrolytic process are either of little or no difficulty, or are common to the retort process.

Electrolytic and Retort Processes Compared

In comparing the two processes, I do not think there is any more experience required in the electrolytic process than in retort smelting, and I shall not be surprised if within the next year or two the electrolytic is preferred as the simpler of the two. It is certain that, with the exception of the care of the electrical machinery, the commonest unskilled labor only is required to produce electrolytic zinc, whereas the retort process requires not only many physically strong, but also very skilled and highly paid men. The amount of labor necessary in the electrolytic process is, however, greater than that required in retort smelting, and also, as a general rule, the current to produce a ton of zinc costs much more than the gas or fuel to produce a ton of spelter. The electrolytic is as much dependetnt on cheap power as the retort process is on cheap fuel. The operation of roasting in Wedge Furnaces is, however, less costly than that in the special furnaces used for roasting the ore for retorting, in which nearly all the sulphur must be eliminated. The labor and power costs are in favor of the retort process.

The following costs for the treatment of run-of-mine ore of a complex nature are based on zinc at 5 cents per pound, St. Louis; lead at 5 cents per pound, and silver at 60 cents per ounce, assuming 88 per cent recovery of zinc. A typical composition of such an ore may be taken as zinc, 30 per cent; lead, 15 per cent, and silver, 12 oz. per ton. The average amount of current required to deposit a ton of zinc is less than 3000 kw.-hr., measured at the vats, when the process is well conducted and the solutions are pure and in good condition. To this must be added the ordinary motor, generator and other losses, and the current incidental to the operating of the factory. Four thousand kilowatt-hours have therefore been allowed per ton of zinc produced, although this amount is more than is necessary in practice:

PRODUCTION OF 25 TONS OF ZINC FROM 95 TONS OF ORE

		Per Ton Zinc	Per Lb. Zinc
100,000 kw.-hr. at ¼ cent	$250.00	$10.00	.50 cent
Labor at $3 and management	310.00	12.40	.62 cent
Fuel and supplies	60.00	2.40	.12 cent
Roasting, including labor and fuel	120.00	4.80	.24 cent
Insurance, maintenance and depreciation	250.00	10.00	.50 cent
	$990.00	$39.60	1.98 cent

Freight on the zinc naturally depends on the location of the electrolytic plant, and as this may be situated in a position difficult of access, we shall allow the ample average sum of $15.00 per ton of zinc:

Costs as above	$990.00	$39.60	1.98 cent
Freight on zinc	375.00	15.00	.75 cent
	$1,365.00	$54.60	2.73 cent
Balance, cost of ore and profit on zinc alone	1,135.00	45.40	2.27 cent
25 tons zinc at 5 cents	$2,500.00	$100.00	5.00 cent

In the case of an ore with the same content of lead and silver, but with 25 per cent zinc, the cost of production would be increased to the extent of 0.05 cent per pound of zinc. Complex ores of this composition are very plentiful, and are of no value unless treated in conjunction with the electrolytic process, for it is impossible to recover the lead and silver by smelting unless the zinc is partly removed. After the sulphur has been nearly eliminated by roasting, and the zinc has been extracted, the residue has only about one-half of the original weight, and the percentage content of lead and silver is doubled. The zinc that has been recovered not only pays for the cost of the ore but leaves a considerable profit, and the lead smelter has now a desirable smelting product containing nearly 30 per cent lead and 24 oz. silver per ton, which costs him nothing, as its cost has been credited to the zinc.

Smelting 48 tons residue, containing 30% lead and 1140 oz. silver, at $5.00		$240.00
Freight on 13 tons lead and silver, at $10.00		130.00
		$370.00
12.65 tons lead at 5 cents	$1,265.00	
1083 oz. silver at 60 cents	649.80	
	$1,914.80	
Deduct smelting and freight	370.00	
Profit on lead and silver	$1,544.80	

No allowance is made for the recovery of vitriol, as it is common to both processes.

Just as soon as the lead or copper smelter recognizes that a good extraction of zinc can be made from his zinc-lead or copper ores, we may expect him to erect an electrolytic zinc plant as an adjunct to his smelter, even though the price of zinc should fall so low that he can make no direct profit from the zinc, provided, of course, that he is favorably situated with regard to cheap power.

Influence and Effect of Manganese

There is another aspect of the question that has not yet received sufficient attention, which will have the effect of turning the balance in favor of the electrolytic process, should it be found that the retort process is still able to hold its own. In the electrolytic process the presence of manganese, in at least a small quantity, is an essential. Its principal function is to prevent sulphating or destruction of the anodes in the electrolytic vats, but it has also other valuable properties, chiefly in purifying the electrolyte. A large part of the manganese is deposited at the anode as hydrated manganese dioxide, concurrently with the deposition of zinc on the cathode. When the zinc ore contains much manganese, which is very frequently the case, the manganese dioxide recovered forms a very valuable by-product. No extra current, or rather, as far as the author's measurements have gone, only a negligible extra quantity of current is required to deposit the manganese. Unfortunately, the particular kind of roasting which is necessary to make the zinc soluble is not that which is most suited to the best recovery of manganese, and, therefore, when manganese is present in a zinc ore only part of it becomes soluble. There is no reason, however, why low-grade manganese ores should not be treated in a special furnace and the solution obtained by leaching added to the electrolyte and recovered as manganese dioxide in the electrolytic vats. The manganese dioxide is particularly well suited for use in dry batteries, quite apart from the demand that exists for manganese in the steel industry. A small quantity of the manganese dioxide deposited is used for the regeneration of manganese sulphate or sulphuric acid. The solution of the zinc in the roasted ore may be conducted in such a way that there is very little or no loss of acid, through the precipitation of basic sulphate of iron, but generally the iron and lead deplete the solution of more sulphate than that furnished by the sulphate of zinc, of which there is usually a small quantity in the roasted ore. Sulphurous acid from the roaster is brought into contact with the manganese dioxide, manganese sulphate is formed, from which dioxide is deposited in the electrolytic vats, and the sulphuric acid with which it was combined is in this way added to the circuit.

There is still further evidence that may be adduced in favor of the future supremacy of the electrolytic process. It is well known that with 5-cent spelter in pre-war time it was impossible for all except the most favorably situated retort smelters to make an adequate profit. The sulphuric acid recovered by some of the smelters enabled them to tide over the bad times, until the surplus stock of spelter had been disposed of. At that time it was very difficult to obtain zinc concentrates, for at the price of $40 per ton of 60 per cent concentrates the miner could not make sufficient profit. So many mines were shut down at that time that various writers attributed the cause to actual depletion of ore in the mines. It has, since that time, been proved that the real reason was that it was unprofitable to work at the prevailing prices. In Canada, and especially in British Columbia, there are vast quantities of complex ores and silver-zinc-lead ores, which it has not been possible hitherto to concentrate to much above 45 per cent. The retort process in Canada is impossible on account of the small supply of ore of sufficiently high grade. The concentrates are very impure and therefore do not command a high price. These concentrates are, however, very easily treated by the electrolytic process. It is imperative that the British Columbia miner shall concentrate his ore in order to separate the valuable silver-lead contents; the zinc concentrates are merely a by-product. The latter generally carry a considerable quantity of silver, of which 65 per cent to 70 per cent is paid for the United States smelters, after first deducting 6 oz. The price paid for the zinc is generally based on 5-cent zinc, $17.00 to $18.00 per ton being given for 40 per cent concentrates. After deducting duty, penalties and freight to the nearest United States zinc smelter, the Kootenay miner received only $5.00 to $7.00 per ton for his zinc concentrates. An electrolytic plant using these concentrates will prove to be a very serious competitor to the zinc smelter who can treat only high-grade concentrates. Even though he were able to treat 40 per cent concentrates as profitably as 60 per cent, the Missouri miner could not supply his 40 per cent concentrates to the smelter at much under $27.00 per ton. The electrolytic plant would thus have an advantage of about $20.00 per ton in the cost of ore, which much more than compensates for the higher cost of production in that process.

It must not be forgotten that when zinc-lead ore occurs in veins it must be concentrated in order to separate the more valuable lead contents, whether the miner is able to dispose of his zinc concentrates or not. Many of them actually run the zinc down the creeks because there is no market for it.

There are, of course, the considerations of cheap electric power, the improvement in flotation methods of concentration, distance from markets, and many others, which affect the future of these rival processes, but I think it must be conceded that it is at least very doubtful whether or not the retort process will be able to survive the competition of the electrolytic process within a few years.

Nelson, B. C.

None of the chromic iron ore mined on the Pacific coast has been concentrated before marketing otherwise than by rough sorting, and yet the grade of a large part of the ore suggests room for improvement in that direction, which could be effected to a large extent by more careful selection.

The Colloidal State of Matter in Its Relation to the Asphalt Industry*

By Clifford Richardson

Asphalt is found widely distributed in nature. It is a form of native bitumen. Bitumen occurs as gas, as naphtha, a very mobile liquid, as petroleum, existing as a liquid of various degrees of viscosity; as maltha, flowing but slowly at ordinary temperatures; in a more or less solid form known as asphalt, and as gilsonite, grahamite, ozokerite, etc.

The liquid forms of bitumen may be regarded as being derived from natural gas by condensation, and the solid bitumens from the liquid in a similar manner, the condensation being assisted by the surface action resulting from the contact of the gases or liquids with the "sands" in which they occur and with which they come in contact.[1]

Asphalt, as it is found in nature, is of very varied character, depending upon that of the particular petroleum in which it has originated. All petroleums do not form asphalt. For example, asphalt does not originate in paraffine petroleum. As petroleums are of a varied character and as those from different fields are sharply differentiated, where asphalt is formed from them, it is a material the character of which is dependent upon that of the oil in which it originates and upon the environment to which this oil has been exposed.

The term asphalt is also applied to the more or less solid residuals obtained industrially by the distillation of certain types of petroleum until the lighter components have been removed and a resulting residual pitch obtained, which, by its consistency and resemblance to the solid bitumens found in nature, is also known as asphalt. It is an artificial or manufactured product. Both the natural and artificial asphalts are used in the construction of pavements and road surfaces, although they are materials of quite different character.

THEORY OF AN ASPHALT PAVEMENT

The surface of an asphalt pavement consists of an aggregate of sand, the particles of which are of a well established and graded size, a filler or fine mineral dust and bitumen in the form of asphalt of proper consistency. From the point of view of the physical chemist it may be considered as a heterogeneous system of two components, or phases, one a solid (a mineral aggregate), and the other a liquid (in the form of bitumen).

A phase is a state or form of matter which is differentiated from some other by a distinct boundary between them. Two phases of this description may be regarded as making up a heterogeneous system. An asphalt surface may be regarded, therefore, as being a heterogeneous system of two components, liquid solid. Ostwald defines a phase as follows:

"By a phase is meant any homogeneous part of a system different from other parts of the system and separated from these by abrupt transitions."

In such a system, asphalt and mineral matter, asphalt must be considered as a liquid phase, since it is combined, while in a melted condition, with a mineral aggregate, a solid phase. Moreover asphalt is strictly a liquid even in a completed pavement, at ordinary temperatures, since it displays a slow flow under pressure at low temperatures. It is also recognized that the liquid component of such a system may differ in concentration at the surface of contact with the solid phase or boundary, where two such phases co-exist.

The mineral aggregate should present a large expanse of surface the development of which, as regards the unit volume of the solid mass which it represents, depends upon its degree of subdivision. Upon the proper relation between the surface thus developed and the volume of liquid, as represented by the asphalt, as well as upon the character and consistency of the latter, that of the asphalt road surface will depend.

IMPORTANCE OF SURFACE PHENOMENA

The importance of surface phenomena as they relate to stability in the construction of asphalt pavements and highway surfaces, has only been definitely recognized during the past few years, although attention was called to some features connected therewith as long ago as 1905 by the writer in a book "The Modern Asphalt Pavement." It was there demonstrated that the finer the mineral aggregate in a sheet asphalt pavement the greater the surface area of the particles which is to be coated with bitumen and the more satisfactory the pavement.

The great advance that has been made in the last ten years in the phenomena connected with the relation of solid surfaces and films of liquid, and especially of the relation of solids in a colloidal state to liquids with which they may be associated, makes it possible to apply the information which has been developed to an interpretation of the phenomena which are connected with the rational construction of bituminous road surfaces.

Energy is displayed by the contact of solid surfaces with liquid films. This is known as surface energy and is illustrated by a thin film of water placed between several pieces of glass, such as the glass slides ordinarily used in examining objects with the microscope, which makes it possible to lift them as one mass without their falling apart.

Where a solid is uniformly dispersed through a liquid this is known we have a physical system. In such a system energy is developed and this energy is proportional to the area of surface displayed by the solid and to the character of the liquid in which it is dispersed. The relation of the extent of surface displayed by the solid and the liquid covering it, plays an important part in the surface energy developed in any system consisting of subdivided mineral matter and bitumen in a more or less liquid form. It is of great interest in reaching a rational interpretation of the relations of these materials in the construction of asphalt pavements and roads.

SURFACE AREA

In 1905 it was shown by the writer, in the book which has been mentioned, that the increased extent of surface offered by a fine aggregate as compared with the coarser material, was enormous. One gram of sand, consisting of grains of uniform size which would pass a 10 mesh sieve and have a diameter of about 2 millimeters would consist of 212 particles having a surface area of 15

*A paper read before the St. Paul Engineering Society, in connection with the Minnesota Engineering Society, May 14 1917.

[1] "The Nature and Origin of Petroleum and Asphalt," *Metallurgical and Chemical Engineering*, Jan. 1, 1917.

square centimeters. If the same weight of material were reduced to a size which would just pass a 200 mesh sieve having openings .08 mm. in diameter the number of particles would be increased to nearly one and a half million and the surface area would be 283 sq. cm. Proceeding still further and reducing the particles to a size of 0.0025 mm. they would number over forty-six billion and the surface area would be more than 9,000 square centimeters. The relation of the surface area of the material as a solid mass to that of the surface of the same material when subdivided, is known as specific surface. This increase in surface area and in specific surface with subdivision is well illustrated in the following data given by Ostwald:

INCREASE IN THE SURFACE OF A CUBE WITH PROGRESSIVE DECIMAL SUBDIVISION

Length of one edge			Number of cubes	Total surface	Specific surface
1	cm.		1	6 square cm.	6
1	mm.	$= 1 \times 10^{-1}$ cm.	10^3	60 square cm.	6.10^1
0.1	mm	$= 1 \times 10^{-2}$ cm.	10^6	600 square cm.	6.10^2
0.01	mm.	$= 1 \times 10^{-3}$ cm.	10^9	6000 square cm.	6.10^3
1.0	μ	$= 1 \times 10^{-4}$ cm.	10^{12}	6 square m.	6.10^4
0.1	μ	$= 1 \times 10^{-5}$ cm.	10^{15}	60 square m.	6.10^5
0.01	μ	$= 1 \times 10^{-6}$ cm.	10^{18}	600 square m.	6.10^6
1.0	$\mu\mu$	$= 1 \times 10^{-7}$ cm.	10^{21}	6000 square m.	6.10^7
0.1	$\mu\mu$	$= 1 \times 10^{-8}$ cm.	10^{24}	6 hectares	6.10^8
0.01	$\mu\mu$	$= 1 \times 10^{-9}$ cm.	10^{27}	60 hectares	6.10^9
0.001	$\mu\mu$	$= 1 \times 10^{-10}$ cm.	10^{30}	6 square km.	6.10^{10}

Particles of a size of 0.1 μ may be regarded as colloidal in relation to water and the development of surface by such subdivision is enormous and, of course, increases with further subdivision. Carried to the limit of ultra-microscopic visibility the surface area would reach 600 sq. m. and the specific surface 6×10^6.

Parts of the mineral aggregate of some asphalt surfaces reach the former state of subdivision. The surface energy developed thereby is very great and has an important bearing on the durability of an asphalt surface.

SURFACE TENSION

As stated by Ostwald, "Surface energy, as usually discussed, is made up of two components; a capacity factor as measured by the absolute surface, and an intensity factor as measured by surface tension. The latter type of surface energy endeavors to decrease the surface of a system if free energy is available."

In a sheet asphalt paving mixture the capacity factor is measured by the degree of fineness of the mineral aggregate, and the intensity factor by that of the character, that is to say, the surface tension, of the bitumen which is in use as a cementing material.

In the case of very fine aggregates the increase in the surface area, that is to say, the specific surface, as has been demonstrated, is enormous, as compared to that of a coarse one and would necessarily call for a larger amount of bitumen to cover it. This fact has an important bearing on asphalt surface mixtures, as prepared from different sands and with different amounts of filler. For example, the mineral aggregate of a coarse New York mixture laid in 1895 was found to have a surface area of about 44 square feet in one pound of material, whereas in a finer one of 1898 this was increased to over 60 square feet. This former was an unsatisfactory, and the latter a very satisfactory pavement. At that time attention was called to the fact that the more extended surface area of the finer aggregate would require a larger percentage of asphalt than the coarser and was more desirable on that account.

No further explanations or conclusions as to the nature of the relations involved were then drawn. With the further study, which has been so widely carried on in the last ten years, of the relation of surfaces and films and of the characteristics exhibited by matter in a highly dispersed or colloidal state, we are to-day in a position to comprehend more fully and explain why this extended surface is a matter of importance in the construction of a satisfactory pavement, and why accepted methods of procedure, which have, hitherto, been founded more or less on an empirical basis alone and not upon certain definite physical laws associated therewith, have been successful. Surface phenomena are now recognized as being of great importance. For a thorough comprehension of the subject, reference must be made to the literature which is available.[2]

Investigations in connection with the relation of the surfaces of mineral aggregates of the type employed in the construction of asphalt pavements and of films of bitumen which serve to cement them together and in other engineering problems as well, have proved of interest not only as explaining the reasons for the successful results obtained in the construction of pavements of the type mentioned, as developed empirically during the last twenty years, but also, carrying these principles much further, in developing the possibility of producing other structural materials containing large percentages of mineral matter in a colloidal state, which are of value as presenting unusual physical characteristics and availability for particular uses.

EARLIER EXPERIENCE CONFIRMED

It was empirically shown as long ago as 1894 to 1896 by the study of successful surfaces that a satisfactory sheet asphalt pavement was one which contained, as part of the aggregate with which the bitumen is combined, a considerable percentage of filler, that is to say, of extremely fine mineral matter. This was attributed to the large extent of surface which such an aggregate offered to which bitumen might adhere, and in this respect was a current inference. At that time, however, the relation of surfaces and films and the principles of the chemistry of matter in a colloidal state had not been made clear, while to-day this subject has been more thoroughly elaborated and affords a means for the rational interpretation of the relation of surfaces and films, as applied to combinations of a mineral aggregate and bitumen, and of the enormous energy developed by the extensive surface presented by solid matter in the colloidal state. This now makes it possible to carry out work of this description on a scientific and rational basis.

COLLOIDAL CONDITIONS

One cannot properly speak of a substance, in itself, as a colloid. The word denotes, rather, a state of matter dependent on the relation of one phase to another, and is one in which all material can exist. It relates, as regards solids and liquids, to the state of subdivision of the former and its dispersion through the latter.

[2] "An Introduction to the Physics and Chemistry of Colloids," by Emil Hatschek, 1916. P. Blakiston's Son & Co., Philadelphia.
"The Chemistry of Colloids," by W. W. Taylor, 1915. Longmans Green & Co., New York.
"Die Welt der vernachlassigten Dimensionen," by Wolfgang Ostwald, Theodor Steinkopff, Dresden, Germany
"Handbook of Colloid Chemistry," by Ostwald, translated by Fischer, 1909. P. Blakiston's Son & Co., Philadelphia.
"The Physical Properties of Colloidal Solutions," by E. F. Burton, 1916. Longmans, Green & Co., New York.
"The Technical Control of Colloidal Matter in Clay," Technologic Paper No. 23. Bureau of Standards, Washington, D. C.

Whether a solid is in a colloidal state or not depends not only on its state of subdivision but upon the viscosity of the liquid or continuous phase or medium in which it is dispersed. A substance, which owing to its degree of subdivision would settle rapidly out of water a mobile aqueous phase, may exist in a colloidal state as regards a very viscous bitumen, such as the heavy residuals of petroleum, which flow but slowly at ordinary temperatures. An example of the latter will be found in Trinidad asphalt, which contains a large amount of fine mineral matter, 25 per cent, which, all of it, exists in a colloidal state as regards the bitumen, although some of it is fine sand, of a size which will be retained on a screen of 100 meshes to the lineal inch. This comparatively coarse material is in a state known as colloidal, because the continuous phase in which it is dispersed may be regarded as a highly viscous liquid.

Clay, as it occurs in nature, is of a very varied character. It is in deposits of different origin, in a more or less colloidal state as regards the water with which it is associated, no doubt depending upon the manner in which it has been formed, whether it is residual or sedimentary, the latter being usually the more colloidal.

It is recognized that clay can be readily diffused in water. Dry clay cannot be readily diffused through the denser forms of bitumen because the individual particles of the clay adhere to one another, and because they are covered with an absorbed film of air or water which prevents its being coated with bitumen. For these reasons dry clay cannot be dispersed uniformly through such a viscous medium as a dense bitumen. If, however, the clay is originally thoroughly dispersed in water as a continuous phase it can then be emulsified with any bitumen which is sufficiently liquid at temperatures below that of boiling water to make it possible. On the removal of the aqueous phase from the emulsion by heating, the highly dispersed clay will then enter into the bituminous phase without difficulty and will then be dispersed therein in a colloidal state or as a colloidal solution of clay in bitumen.

COLLOIDAL BITUMENS

Clay in a colloidal state can also be introduced in the same way with greater facility into the more liquid types of asphaltic bitumen. The amount, introduced in this way, may reach with certain oils as much as 60 per cent. Such a material may be used for fluxing the harder bitumens for the purpose of introducing colloidal clay into them in a simpler manner than by attempting to do so directly. With a sufficient amount of clay in a colloidal state in the flux, the latter has such stability that it can be shipped without packages. Combinations of asphalt and colloidal clay may be obtained in this way which present some extraordinary and valuable characteristics from an industrial point of view.

The native asphalts of a highly viscous nature, and the heavy residuals derived from asphaltic petroleum, possess, however, very different capacities for maintaining clay in suspension in a colloidal state, and this capacity differentiates them in a striking manner, demonstrating the difference in character of the components of which these asphalts are made up. This is illustrated by the determinations of what may be called the capacity of various asphalts to maintain colloidal clay in suspension under different conditions. Colloidal clay was introduced into a number of solid residuals of various types of petroleum, by the addition of enough aqueous clay paste to result in a material which, after removal of the water, should consist of 67 per cent. bitumen and 33 per cent clay. These materials were maintained in a melted condition, at a temperature of 325 deg. F. in tubes for 24 hours. The sedimentation which, with the reduction of the viscosity of the continuous phase, went on in that period, appears from the following figures:

Colloidal Capacity of Various Types of Bitumen

Mixtures of 67 Per Cent Bitumen and 33 Per Cent Clay Introduced Wet, Maintained at 325 Deg. F. for Twenty-four Hours

Source	Penetration	Per Cent Colloidal Matter Before Heating	Per Cent Colloidal Matter After Heating	Per Cent Sedimentation
Trinidad Residual	50	33.5	33.7	0.0
Bababui Residual	48	32.4	30.1	7.0
Mexican Residual	50	33.3	27.2	18.3
California Residual	50	31.8	23.8	25.2
Mid-Continental Semi-Paraffine Residual	51	33.8	21.7	35.8

The colloidal capacity thus determined is a function of the character of the particular bitumen and also of its viscosity at the temperature concerned. The striking feature is that the residual asphalt prepared from semi-paraffine petroleum of the Mid-continental field deposited 35.8 per cent of the clay at high temperature, showing the small capacity of paraffine oils to maintain clay in suspension in a colloidal state. At the other extreme a Trinidad residual deposits nothing under the same circumstances. A Bababui residual, prepared from a Venezuelan petroleum, which is heavier than water when it emerges from the well, deposits but 7 per cent, a Mexican residual 18.3 per cent, while the California residual deposits an increased amount.

As the film of bitumen which covers the mineral aggregate of a sheet asphalt pavement is formed at the temperature given, these data may convey some idea as to the capacity of the different materials for coating the grains of this aggregate, but too much dependence must not be placed upon them as there are so many other controlling features in relation to the character of the films. It is striking, however, that the Trinidad residual is so thoroughly differentiated from all the others, thus confirming the opinion, based upon service tests, in regard to the unique character of this material.

If the same mixtures of bitumen and colloidal clay are examined in a 10 per cent solution in carbon-disulphide, which has been submitted to centrifugal action, the results are equally striking.

The Trinidad residual again has the greater colloidal capacity, while the Mexican residual, under the conditions, shows a decided reduction in this respect, while the semi-paraffine, Mid-continental material, again has the smallest capacity. This capacity of different bitu-

Colloidal Capacity of Various Types of Bitumen

In Mixtures of 67 Per Cent Bitumen and 33 Per Cent Colloidal Clay

Sedimentation of 10 Per Cent Solutions on Centrifuging. In Carbon-Disulphide

Source	Per Cent Remaining in Suspension
Trinidad Residual	2.23
Bababui Residual	1.91
California Residual	1.89
Mexican Residual	0.94
Mid-Continental Semi-Paraffine Residual	0.54

mens of the same consistency for maintaining clay in a colloidal state, under different conditions, is strong evidence of the fact that asphalt from various sources is of a different character.

Trinidad lake asphalt after the removal of the water by heating, that is to say, in a refined condition, contains about 35 per cent of anhydrous mineral matter, as determined by ignition, all of which must have been in a colloidal state, since the amount found in all parts of the deposit is the same and this uniformity can only be accounted for on this supposition. If this asphalt is dissolved in carbon-disulphide or benzol to form a solution of varying degrees of concentration and centrifuged to remove the mineral matter which is too coarse to remain in the colloidal state, in a liquid of the viscosity corresponding to the concentration, the resulting solutions will be found to contain a percentage of colloidal matter varying with the concentration and viscosity. The data which have been obtained as the results of experiments along these lines are as follows:

CHARACTERIZATION OF SOLUTIONS OF TRINIDAD ASPHALT

Per Cent Concentration	Specific Gravity	Increase for 1 Per Cent	Absolute Viscosity	Difference for 1 Per Cent
Benzol	.876	....	0.00652	.....
1 per cent T. R. A.	.877	.0010	0.00654	0.00002
2 per cent T. R. A.	.879	.0020	.000687	0.00033
5 per cent T. R. A.	.883	.0013	0.00759	0.00024
10 per cent T. R. A.	.889	.0012	0.00961	0.00040
20 per cent T. R. A.	.911	.0022	0.01629	0.00067
30 per cent T. R. A.	.930	.0019	0.04198	0.00257
40 per cent T. R. A.	.957	.0027	0.09477	0.00521
50 per cent T. R. A.	1.012	.0055	0.31800	0.02240
100 per cent T. R. A.	1.400	.0076	.....	.....

CHARACTERIZATION OF SOLUTIONS OF TRINIDAD ASPHALT

Per Cent Concentration	Refined—Per Cent Colloidal Matter	Refined—Amount for 1 Per Cent
1 per cent	2.54	2.54
2 per cent	2.01	1.00
5 per cent	2.09	.42
10 per cent	2.73	.27
20 per cent	3.13	.16
30 per cent	4.19	.14
40 per cent	6.51	.16
50 per cent	10.69	.21
100 per cent	35.40	.35
Cn Benzol.		

The percentage of clay in a colloidal state varies but slightly for concentration of from 1 to 10 per cent, but increases gradually above this. These changes are most strikingly brought out if the increase is calculated for 1 per cent for the different intervals, as shown in the tables. The amount decreases gradually per unit of bitumen until the concentration of 40 per cent is reached, when it again increases up to 100 per cent, which is not, however, a maximum.

It appears from these figures that this result might be due to irregularities in changes in the viscosity of the solutions under examination with concentration, but determinations have shown that this is not the case, since the absolute viscosity increases in a perfectly regular way. The same may be said in regard to the increase of the specific gravity of the solution. On plotting these data it appears that the curves show that the changes in specific gravity are represented by a straight line, or approximately so, the curve for absolute viscosity by a paraboloid, and that for suspended solids by a slightly irregular paraboloid. It appears then that the increase in the amount of clay in a colloidal state is gradual for a lower but sharp for the higher concentrations.

The peculiar relations of colloidal clay and bitumen as demonstrated by the preceding data are of great interest. They serve to demonstrate the importance of the relations of surfaces and films and of the peculiar role played by matter in a colloidal state in connection with combinations of bitumen and mineral matter as employed in paving and road construction. It can be readily seen that the relations of water as a continuous phase and mineral matter in various degrees of dispersion can be interpreted along similar lines and are of importance to the engineer in many connections. It is a subject which, in this direction, has received only superficial attention up to the present time.

New York City.

Dezincification of Brass Pipe

By Edward B. Story

Some ten or twelve years ago brass pipe began to be used commercially for water systems. The idea, prevalent to that time, was that such an installation should give a much longer life than steel or even iron pipe. This idea was based entirely on the one fundamental fact that brass seemed to stand up well from a corrosion standpoint. However, after a few years of service, and indeed in much shorter time than was anticipated, brass pipe began to show evidence of deterioration.

The tough and ductile brass seems to metamorphose itself into a very weak and brittle form, so that comparatively slight stresses due to shock, vibration, expansion or contraction, which the normal brass would have no difficulty to withstand, are now sufficient to cause cracks and occasionally complete failure. The failure usually occurs at the joints, presumably so because of the thinner wall section and threading.

Aggravations reach a climax when an attempt is made to remove a failed or leaky joint, for the torsional stress attending the uncoupling or coupling is again sufficient to cause a failure in some other length or joint in the installation. Consequently, one failure results from an endeavor to repair a previous one, and it is difficult to estimate just how many lengths will have to be ultimately replaced before the repair is completed. Thus aside from the labor and inconvenience, the cost of the new material installed results in quite an item of expense.

Brass pipe that has become brittle and weak is invariably accompanied by a grayish white, seemingly carbonaceous deposit, appearing profusely on the interior walls and frequently in patches on the exterior of the pipe. When the brass is scraped clean of this deposit, the underlying metal appears much redder in color than the surrounding brass, and in fact to such a marked degree that to all outward appearances it resembles copper very closely. This led to the belief that perhaps the brass undergoes some decomposition reac-

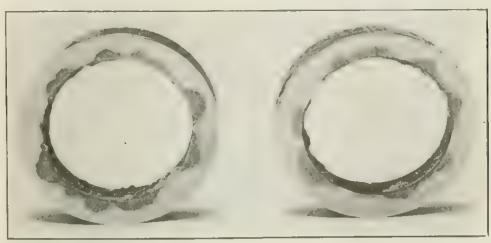

FIG. 1—"DEZINCIFIED" BRASS PIPE. DARK AREAS ARE BRASS DEPLETED IN ZINC. MAGNIFICATION 3 DIAMETERS

tion in which there is a depletion in zinc, or what might be better termed "dezincification." Analysis of the carbonaceous deposits indicates that the zinc content is relatively high, only traces of copper being present, which of course substantiates, to some extent, the conjecture that the brass has been dezincified.

In order to examine more clearly these apparently dezincified regions, sections were sawed from the affected pipe, and after grinding and polishing the areas showed themselves quite clearly. Heat tinting further developed the contrasted areas. Figure 1 shows two such sections of the pipe at a magnification of three or four times. The areas are easily discernible by their darker color, and appear as an inside border which projects quite deeply into the body metal at places. Occasionally the action starts on the interior surface of the pipe and, continuing, completely dezincifies the entire wall section, emerging at the exterior; or, action starts both on the interior and exterior, meeting in the center of the wall section.

As stated above, these cases are uncommon, probably because the pipe in general cannot remain in service long enough for such conditions to become evident.

The dezincified portions do not adhere strongly to the other metal, for only a slight pressure with a tool is sufficient to dislodge them. The ease with which they can be removed, and the character and appearance of the cleavage, give evidence that they are the result of a depositing action.

Analysis of these dislodged dezincified particles gives the following composition:

(Sample)	Original Brass A. Per Cent.	Original Brass B. Per Cent.	Dezincified Brass A. Per Cent.	Dezincified Brass B. Per Cent.
Copper	58.40	60.10	85.70	94.50
Zinc	40.60	39.30	13.97	4.49
Lead	0.37	0.21	Trace	0 06
Tin	Trace	Trace	Trace	Trace
Other impurities	Not determined		Not determined	

This analysis gives substantial evidence that the brass has been dezincified in segregated zones.

Microscopical Examination

The specimen after polishing was etched with hydrogen peroxide in presence of ammonia. Figs. 2, 3, 4 and 5 are microphotographs taken at 100 diameters. Although the areas high in copper appear in sharp contrast to the normal brass areas when viewed with the naked eye as shown in Fig. 1, yet the microscope reveals that there is no sharp line of demarcation, but that the dezincified portions high in copper are separated from the normal brass by a region that shows incomplete dezincification in which the depletion in zinc is less the closer we get to the brass.

In Fig. 2 the upper dark portion is the normal brass which shades off in the central part to a less dense structure which is the partly dezincified brass, and the lower dark colored area shows the copper which has been practically depleted of zinc. The white areas and also the white structureless band are copper regions, and are the same as the pure copper showing dark at the bottom. The white copper areas in the partly dezincified zone and also the white band not assuming a structure, are due to the fact that pure copper is negative with respect to brass, and in the range of incomplete dezincification there still remains some unchanged brass which protects the pure copper from action by the etching agent. This protection is similar to that given iron and steel by galvanizing. However, when the pure copper areas are far enough distant from the unchanged brass, sufficient protection is not afforded, and we then have an attack on the copper by the etching agent, with a resulting structure revealed as in the lower portion of the microphotograph.

In Fig. 3 the dezincification is revealed as taking place from the two sides, evidenced by the copper appearing

FIG. 2—BRASS UNDERGOING "DEZINCIFICATION." MAGNIFICATION 100 DIAMETERS

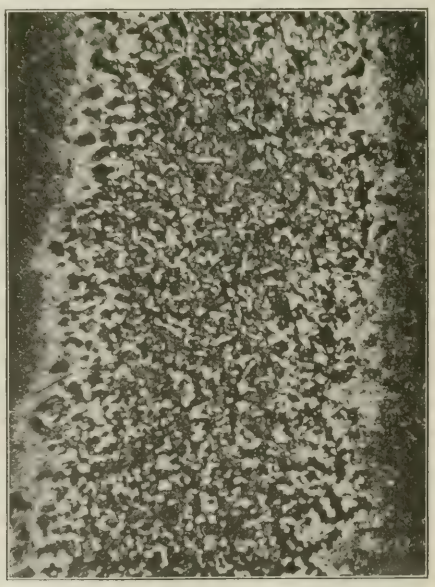

FIG. 3—BRASS UNDERGOING "DEZINCIFICATION." MAGNIFICATION 100 DIAMETERS

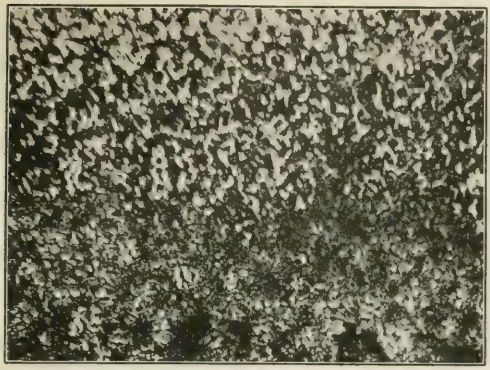

FIG. 4—PARTLY "DEZINCIFIED" BRASS

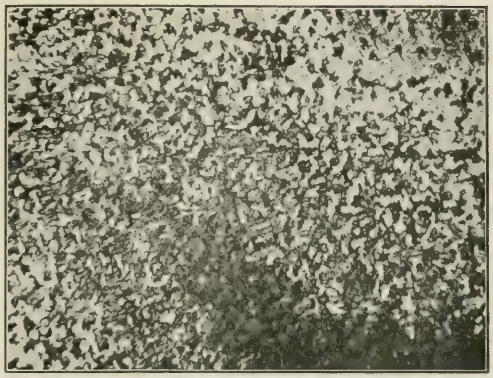

FIG. 5—PARTLY "DEZINCIFIED" BRASS

as dark bands on either edge of the central portion, which shows incomplete dezincification. This photograph shows a case previously alluded to, in which the action had started on the exterior as well as the interior and the pipe had been dezincified entirely through the wall except for the slight portion shown in the central part of the photograph. The white structureless copper bands are again showing where the remaining grass has exercised sufficient protection against the action of the etching agent.

Figs. 4 and 5 both depict regions where the brass is undergoing dezincification. They show clearly that the regions depleted in zinc are not sharply defined from the normal brass, but that there are intermediate regions where the action has partly completed itself, leading one to believe that the action is a rather progressive one. As in the previous photographs, the dark areas are the brass, the white ones the copper.

Theory and Mechanism of Dezincification

Brass is primarily an alloy of copper and zinc, the commercial forms containing small quantities of contaminants such as lead, tin and other impurities. The range of composition is very wide, and the cheaper yellow or white brasses may contain as little as 2.5 per cent copper. The better brasses, the red ones, usually contain 60 per cent or more of copper.

Although the brasses probably have been investigated more thoroughly than any other non-ferrous alloy, yet, owing to their very complex nature, the exact constitution of brass is still to be definitely settled. From the more recent researches authorities now seem generally to agree that brass is in the group forming chemical compounds, with probably some mixed crystals. In the light then of this generally accepted theory of the constitution of brass (*i. e.*, forming chemical compounds of copper and zinc), it is evident that any solution or chemical reaction does not affect either the copper or zinc individually, but the copper and zinc are both affected in the ration of the amounts which form the chemical compound. The microphotographs bear this out clearly, for if the zinc were leached out with no action on the copper, then the pure remaining copper areas should show a honeycombed structure, which is not the case.

There are a number of factors that can cause a solution of the brass: a strained condition of the brass, impurities, segregation, or the presence of two or more chemical compounds, any one of which would tend to produce zones of varying electro-chemical characteristics, and which in the presence of water acting as an electrolyte would cause reactions to be set up whereby the brass goes into solution. When in solution, the copper and zinc are no longer in an atomic or molecular state, but have been ionized, the copper ions being electronegative, and the zinc ions electropositive with respect to the existing unaffected brass. This condition cannot exist, and the electronegative ions are discharged on the surface of the brass with resulting deposits of metallic copper. Of course, the solution of the brass and the deposition of the pure copper is practically an instantaneous action and restricted to the localized spot where solution was originally effected. When once a mere trace of copper has been deposited, we have ideal conditions for further solution, for the brass is now electropositive to the newly deposited copper with the result that more brass goes into solution with, of course, deposits of corresponding masses of copper.

Thus it is evident that only the slightest cause, such as segregation, strain and other previously mentioned reasons which may seem remote and of little consequence, are sufficient to produce the nucleus of pure deposited copper and start the endless action that will ultimately result in the failure of the brass pipe.

Research Department,
A. M. Byers Co.,
Pittsburgh, Pa.

The greatly increased trade in steel and the consequently larger demand for ferrochrome have stimulated the search for chromite in the United States, as is shown by the fourteenfold increase in production in 1916 as compared with 1915. There were four producing States in 1916. On the Atlantic coast and in Wyoming there was only a small production, but in the Pacific Coast States, especially California, the advance in the output has been remarkable. Maryland and Wyoming had one producer in each State. Oregon, with about half a dozen producers in three counties, had a production which, combined with that of Maryland and Wyoming, amounted to 3,277 tons, valued at $43,306; California produced 43,758 tons.

The United Eastern Mill*

By Otto Wartenweiler

The character of the ore for which this mill was erected is similar to that of other mines in the Oatman, Ariz., district, where milling plants have been in successful operation for several years.

The ore consists of a mixture of calcite and quartz in about equal quantities with some decomposed andesite, while the average value of mill head was calculated to be $20 plus in gold, no silver being present. The tonnage to be treated at the start was fixed at 200 tons, but it was considered advisable to arrange facilities for increasing the capacity to 400 tons. While it is best in some cases to adopt a distinct independent unit system where future enlargement is contemplated, in this instance the plans worked out differently. Summarized, the treatment adopted consists of coarse crushing, coarse grinding, fine grinding and cyanidation.

For coarse crushing the selection of the No. 6 size gyratory crusher was governed not so much by its capacity as by the size of the feed openings to properly receive the run-of-mine material, which was too coarse for a No. 5 crusher.

To accomplish the coarse grinding to best advantage, a careful comparison was made between the modern steel ball-mill—the last word in crushing and grinding—and one of its older, and at that time better established, competitors, the rolls. The following conclusion was reached: While it is possible that for the sized plant under consideration the cost of operating rolls might be a little cheaper, it is preferable to use ball-mills because a simpler arrangement is possible, and because the handling of ball-mills is preferred by the operator.

A marked departure was introduced for fine grinding. Instead of the long type of tube-mill, using pebbles, a mill of similar design was selected, but of much shorter length, using small cast-steel balls as grinding medium.

For cyanidation, the Dorr continuous countercurrent process was adopted, its advantages for these conditions having been clearly demonstrated in one of the local mills.

Pumping Plant

The water supply is taken from a well about 4 miles from the mill. The well pit was enlarged and a 2-in. centrifugal booster pump set down about 20 ft. below surface, pumping into a tank from whence a 4 by 8-in. Dow triplex pump driven by a 30-hp. motor supplies a 4-in. pipe line at 400 lb. per square inch pressure and 75 gal. per minute. Immediately at the pump discharge a water relief valve set at 500 lb. per square inch is installed, and beyond this is a standpipe or air cushion made of 10-in. pipe and fittings and connected to a hydraulic air-pump. Beyond the standpipe and outside of the pump house is a check valve to protect the house and contents in case of a break below the valve. The pipe line goes over rough country and lies on the surface except where it crosses Silver Creek, at which place it is buried about 3 ft. for a length of about 300 ft. It has expansion joints made up of four ells and three short pieces of pipe about every 500 ft. The tops of all important vertical bends have air-outlet valves and the bottoms have drain cocks. The four-ell expansion joints aid materially in laying the pipe over irregular country, while the resistance is small because of the low velocity of the water. The pipe line ends at two water-storage tanks having a capacity of 75,000 gal. each and located about 75 ft. above the surface plant. From here a 4-in. gravity line serves the mill and mine.

*Excerpt of a paper to be presented at the New York meeting of the Amer. Inst. of Min. Eng., Feb., 1918.

Cost of Construction of Milling Plant and Miscellaneous Buildings as at January 31, 1917

Account Title	Labor	Material	Power	Miscellaneous	Total
Mill:					
Mill proper	$32,211.08	$90,328.04	$135.81	$10,864.16	$133,539.09
Crushing plant	2,456.50	9,504.81		14.06	11,975.37
Coarse ore bins	953.97	962.30			1,916.27
Refinery	2,093.52	3,695.61			5,789.13
Miscellaneous:					
Machine shop	815.02	7,407.92			8,222.94
Storehouse	824.74	2,266.60			3,091.34
Transformer house	517.64	4,109.53			4,627.17
Assay office	457.90	1,711.77			2,169.67
Inclined tramway	224.02	880.84			1,104.86
Water system	2,197.34	18,780.23		3,321.31	24,298.88

Table I—Main Mill Construction

	Labor	Material	Power	Miscellaneous	Total
Excavation	$10,897.04	$2,203.52			$13,100.56
Concrete	5,473.74	4,411.18	$21.54	$945.85	10,852.31
Machinery, f. o. b. Oatman[1]		57,487.02			57,487.02
Machinery, erection	4,022.18	862.36	114.27	390.75	5,389.56
Building lumber		7,411.87			7,411.87
Lumber framing and erection	5,205.89	538.02		420.96	6,164.87
Building covering in place	821.50	2,302.77			3,124.27
Doors and windows in place	183.06	75.16			258.22
Wood tanks, f.o.b. Oatman		7,811.06			7,811.06
Wood tanks, erection	939.27	122.80		3.62	1,065.69
Piping, f.o.b. Oatman		2,864.93			2,864.93
Piping, erection	1,329.63				1,329.63
Electric wiring, f.o.b. Oatman		2,906.89			2,906.89
Electric wiring, erection	1,483.04				1,483.04
Belting in place	18.06	722.22			740.28
Launder lumber		71.57			71.57
Launders, erection	412.14	22.87			435.01
Engineering, Los Angeles Office				9,050.99	9,050.99
Engineering, field	749.05	182.80		51.99	983.84
Tailings dump and fences	330.87	24.89			355.76
Furniture and fixtures	6.50	51.50			58.00
Painting	221.87	132.30			354.17
Small tools and equipment	117.24	122.31			239.55
Total mill construction	$32,211.08	$90,328.04	$135.81	$10,864.16	$133,539.09

[1]See note under refinery, Table 4.

Table 2.—Crushing Plant Construction

	Labor	Material	Miscellaneous	Total
Excavation	$502.00	$333.25		$835.25
Concrete	251.10	351.68		602.78
Machinery, f.o.b. Oatman		6,323.73		6,323.73
Machinery, erection	671.20	103.27		774.47
Building lumber		1,208.48	$14.06	1,222.54
Lumber framing and erection	704.20	77.82		782.02
Building covering in place	4.00	325.86		329.86
Doors and windows in place		19.74		19.74[1]
Electric wiring, f.o.b. Oatman		184.46		184.46
Electric wiring, erection	118.53			118.53
Belting in place		586.82		586.82
Engineering, field	124.85			124.85
Painting	80.62	29.18		109.80
Total crushing plant construction	$2,456.50	$9,504.81	$14.06	$11,975.37

[1]Credit.

TABLE 3—COARSE ORE BINS

	Labor	Material	Total
Excavation	$44.50	$144.75	$189.25
Concrete	520.96	61.88	582.84
Building lumber		741.63	741.63
Lumber framing and erection	368.51	14.04	382.55
Engineering, field	20.00		20.00
Total coarse ore bins	$953.97	$962.30	$1,916.27

Mill Site

The mill site was chosen on a hill having its apex near the strike of the United Eastern vein, the top of the hill being suitable for the surface plant and the side of the hill having the necessary slope for the grinding departments. A level site for the cyanide plant was obtained by excavation, and the top of the hill was leveled off for the surface plant. It was of considerable importance to have the mill tailings discharge at as high an elevation as possible, on account of the topography of the country required for tailing shortage, and therefore the mill building was pushed further up the hill than it otherwise would have been.

Crushing Plant

The primary crushing department consists of a No. 6 Telsmith crusher belted to a 50-hp. motor and is automatically fed by a 42-in. steel apron feeder moving 1½ ft. per minute and discharging 25 tons per hour. The ore is crushed to 3 in. and drops onto an 18-in. wide 20 deg. inclined belt conveyor passing over a Merrick weightometer and is discharged into a 24 by 24-ft. circular wooden tank bin, having its discharge gate in the center of the bottom. This represents the ideal case for loading and discharge, giving the maximum capacity for the size of the bin; less expensive than a rectangular bin and more efficient. The bottom of the bin is built of 4-in. material while the staves consist of 3-in. material, all Oregon pine lumber. The hoisting and primary crushing is intended to be done in one shift.

Mill

The coarse-grinding department consists of two No. 64½ Marcy mills each direct-connected to 100-hp.

TABLE 4—REFINERY

	Labor	Material	Total
Plastering	$18.62		$18.62
Excavation	149.75		149.75
Concrete	808.06	$498.22	1,306.28
Machinery, f. o. b. Catman		1,439.14	1,439.14
Machinery, erection	213.24	90.73	303.97
Building lumber, f.o.b. Catman		68.06	68.06
Lumberframing and erection	358.20	5.50	363.70
Building covering in place, includes steel trusses	62.00	1,007.22	1,069.22
Doors and windows in place	141.75	147.76	289.51
Tank, f.o.b. Catman		53.35	53.35
Piping, f.o.b. Catman		219.14	219.14
Piping, erection	9.56		9.56
Electric wiring, f.o.b. Catman		31.75	31.75
Electric wiring, erection	46.62		46.62
Engineering, field	63.10		63.10
Furniture and fixtures	3.37	109.58	112.95
Painting	68.13	5.96	74.09
Concrete blocks	151.12	12.00	163.12
Small tools and equipment		7.20	7.20
Total Refinery	$2,093.52	$3,695.61	$5,789.13

Precipitation presses were not charged in this account. The Merrill contract did not specify separate prices, and two precipitation presses and one clarification press, and zinc feeder, were charged to mill. The charge was:

Three presses and zinc feeder	$8,450.00
Freight	439.20
Hauling	126.00
Total	$9,015.20

TABLE 5—MACHINE SHOP

	Labor	Material	Total
Excavation	$25.50		$25.50
Concrete		$35.56	35.56
Machinery, f.o.b. Catman		6,473.94	6,473.94
Machinery, erection	292.69	37.10	329.79
Building lumber		483.05	483.05
Lumber framing and erection	362.85	48.65	411.50
Building covering in place		159.17	159.17
Doors and windows in place	18.33	68.47	86.80
Electric wiring, f.o.b. Catman		44.34	44.34
Electric wiring, erection	46.68		46.68
Engineering, field	13.10		13.10
Furniture and fixtures	9.00		9.00
Painting	46.87	29.76	76.63
Small bench tools		27.88	27.88
Total machine shop	$815.02	$7,407.92	$8,222.94

Allis-Chalmers motors through flexible couplings and herringbone gears; automatically fed at the rate of 8½ tons per hour by an 18-in. steel apron conveyor traveling at the rate of 1½ ft. per minute, taking the crushed ore from the bottom of the circular tank bin, its discharge being split for each ball-mill. Each Marcy mill operates in closed circuit with a duplex Callow screen, the oversize of which is returned to the Marcy mill by an 18-in. belt and bucket elevator and the undersize (—30-mesh) goes to a combined distributer and sampler. The feed to the Callow screens is arranged so that either Marcy mill may work with either screen. Before deciding on Callow screens for this separation, Dorr classifiers were considered, the idea being that they were more economical in operation, and that the special elevator for returning the +30-mesh might be eliminated, but since up to that time a Dorr classifier had not been proved to be satisfactory on material coarser than 48-mesh, preference was given to the Callow screen.

The work intended for one ball-mill operating in closed circuit as described consists of grinding 200 tons of ore that has passed a 3-in. ring to a product passing a 30-mesh screen per 24 hours, the mill being loaded with from 7000 to 8000 lb. of 5-in. balls. While one ball-mill apparently would have been of sufficient capacity for the initial mill tonnage required, it was deemed advisable to install a second machine, having in mind the possible increase in tonnage which soon may have to be met, and also realizing the necessity of a standby machine to secure continuous operation of the plant. The Marcy mills are fitted with specially designed feed scoops, so that the wet rejects from the Callow screens are taken in at the periphery while the dry ore from the feeder goes directly into the center of the scoop.

The fine-grinding department is composed of three Allis-Chalmers tube mills, 5 ft. in diameter by 6 ft. long, each direct-connected to 75-hp. motors through flexible couplings and herringbone gears, operating in closed circuit with a Dorr duplex classifier. The feed comes from the combined distributer and sampler to

TABLE 6—STOREHOUSE CONSTRUCTION

	Labor	Material	Total
Excavation	$199.48	$1.40	$200.88
Concrete		13.31	13.31
Building lumber		1,389.64	1,389.64
Lumber framing and erection	456.11	67.69	523.80
Building covering in place		223.89	223.89
Doors and windows in place	85.75	120.96	206.71
Electric wiring, f.o.b. Catman		30.42	30.42
Electric wiring, erection	19.25		19.25
Engineering, field	6.65		6.65
Furniture and fixtures	30.00	429.29	459.29
Painting	27.50		27.50
Total storehouse construction	$824.74	$2,266.60	$3,091.34

Table 7—Transformer House and Equipment

	Labor	Material	Total
Excavation	$148.05	.....	$148.05
Concrete	2.00	.....	2.00
Machinery, f.o.b. Oatman	.....	$3,327.77	3,327.77
Machinery, erection	51.12	22.40	73.52
Building lumber	.....	174.31	174.31
Lumber framing and erection	40.25	.....	40.25
Building covering in place	7.50	92.69	100.19
Electric wiring, f.o.b. Oatman	.....	475.83	475.83
Electric wiring, erection	181.21	.....	181.21
Engineering, field	60.00	.....	60.00
Painting	27.50	16.53	44 03
Total transformer house and equipment.	$517.64	$4,109.53	$4,627.17

the Dorr classifier, the coarse discharge of which is taken into the tube mill by a 42-in. scoop. The Dorr classifiers overflow into a launder to a Callow 8-ft. sloughing-off tank where additional settling is expected to take place. These tube mills, or ball-peb mills as they are designated by the manufacturer, are built to use ⅞-in. diameter cast-steel balls instead of pebbles as grinding medium. Like the ball mills, they are lined with steel. The work intended for one ball-peb mill operating in closed circuit consists of grinding 133 tons of 30-mesh feed so that 85 per cent of the discharge will pass through a 200-mesh screen, using a charge of 13,000 lb. of ⅞-in. diameter ball pebs. It will be noticed that in the fine-grinding department the same idea referring to future increase in tonnage as well as standbys again was observed. In adopting these extremely short tube mills for fine grinding preparatory to cyanidation, considerable hesitancy was displayed, since excepting some information on dry work in cement plants, no records of operating results were obtainable. But it is only fair to say that the manufacturer was willing to substantiate his claim with the requested tangible operating guarantees. The results obtained at this writing are not absolutely conclusive, but it appears that the work of both types of machines will be well within their respective expectations.

Continuous countercurrent decantation is the cyanide process used, in which the pulp continuously flows toward the lower end while the clear solution continuously flows toward the upper end. The cyanide solution is entered at the Marcy mills and most of the values will be dissolved before reaching the first cyanide tank. The cyanide plant has five Dorr thickener tanks 40 by 12 ft. and four Dorr agitators 24 by 14 ft., arranged in the following order: thickener, three agitators, thickener, agitator, three thickeners. Each thickener has a Campbell and Kelly diaphragm

Table 8—Assay Office

	Labor	Material	Total
Excavation	$23.25	.....	$23.25
Concrete	13.14	$8.52	21.66
Machinery, f.o.b. Oatman	.....	152.97	152.97
Machinery, erection	31.89	1.37	33.26
Building lumber	.....	296.06	296.06
Lumber framing and erection	107.90	4.86	112.76
Building covering in place	.....	89.70	89.70
Doors and windows in place	33.00	38.27	71.27
Wood tanks, f.o.b. Oatman	.....	53.35	53.35
Wood tanks, erection	0.75	.....	0.75
Piping, f.o.b. Oatman	.....	7.65	7.65
Electric wiring, f.o.b. Oatman	.....	27.72	27.72
Electric wiring, erection	27.56	.....	27.56
Belting in place	.....	2.25	2.25
Engineering, field	6.65	.....	6.65
Furniture and fixtures	68.13	623.32	691.45
Painting	18.13	10.41	28.54
Small tools and equipment	127.50	395.32	522.82
Total assay office	$457.90	$1,711.77	$2,169.67

Table 9—Inclined Tramway

	Labor	Material	Total
Excavation	$127.75	$0.57	$128.32
Concrete	12.06	8.52	20.58
Machinery, f.o.b. Oatman	.....	806.37	806.37
Machinery, erection	37.77	63.69	101.46
Lumber framing and erection	13.37	.....	13.37
Electric wiring, f.o.b. Oatman	.....	1.41	1.41
Electric wiring, erection	26.62	.....	26.62
Engineering, field	6.45	.....	6.45
Painting	.....	0.28	0.28
Total inclined tramway	$224.02	$880.84	$1,104.86

pump located above the tank to pump the pulp into the following tank. The first thickener is taking the overflow from the Callow sloughing-off tank, the pulp discharged is pumped into the first agitator, and the clear solution overflow goes by gravity through a solution meter and thence into a 20 by 10-ft. press-solution tank. The pulp passes through the first three agitators and into the second thickener by gravity, thence by pump to the fourth agitator, thence by gravity to the third thickener, and thence by pump to the fourth and fifth thickeners and tailings launder respectively. The second thickener overflow is returned to the mill-solution supply tank at the head of the mill via a priming tank and centrifugal pump. The third thickener overflow is returned to the first agitator by similar means. The fourth thickener overflow may go by gravity to the third thickener or at option may be pumped to the fourth agitator. The fifth thickener overflow goes by gravity to the fourth thickener. Barren solution is added to the launder from No. 4 thickener to No. 3 thickener and fresh water to the launder from No. 5 thickener to No. 4 thickener. The three centrifugal pumps handling the clear solution are each connected to a fourth pump acting as standby. Each pump is direct-connected, motor-driven, and equipped with automatic float switch at the priming tank to shut off the motor should the priming tank be drained. A small compressor is installed to supply air to the agitators at 20 lb. pressure.

The solution from the first thickener after entering the press-solution tank is pumped by a centrifugal

Table 10—Water System

	Labor	Material	Miscellaneous	Total
Bergman ranch:				
Well and pit	$1,425.07	$680.57	$49.41	$2,155.05
Plant and building	.....	272.87	.....	272.87
Pumping machinery, f.o.b. site	.....	1,480.04	.....	1,480.04
Pumping machinery, installing	21.62	10.92	1.00	33.54
Electrical equipment, installed	35.62	1,439.98	5.90	1,481.50
Pipe and fittings, f.o.b. Kingman	.....	8,727.80	.....	8,727.80
Pipe and fittings, hauling and distribution	.....	1,406.85	.....	1,406.85
Two storage tanks, installed, 75,000 gal	32.25	1,546.87	.....	1,579.12
One small tank	.....	71.10	.....	71.10
Pumpman's residence	91.27	886.47	.....	977.74
G. A. Heckler, contract	15.00	56.00	3,179.00	3,250.00
Engineering, field	71.45	.....	86.00	157.45
Total Bergman ranch	$1,692.28	$16,579.47	$3,321.31	$21,593.06
Well test	$126.75	$30.96	.....	$157.71
Big Jim to mill, system:				
Engineering, superintendence, maintenance	$6.00	.....	.....	$6.00
Pipe and fittings, f.o.b. Oatman	.....	$2,169.34	.....	2,169.34
Pipe and fittings, distribution	43.11	.....	.....	43.11
Installing line	238.70	0.46	.....	239.16
Storage tank, installed complete	90.50	.....	.....	90.50
Total Big Jim to mill, system	$378.31	$2,169.80	.....	$2,548.11
Total water system	$2,197.34	$18,780.23	$3,321.31	$24,298.88

pump through a 3½ by 3½-ft., 28-frame Merrill clarifying press, the clarified solution going by gravity to a 20 by 10-ft. gold tank. From here a 7 by 8-in. Platt Iron Works pump sends the pregnant solution through two Merrill 36-in., 32-frame precipitation presses, zinc dust having been added my means of a feeder and emulsifier to the pipe from the gold tank to the triplex pump. Duplicate triplex and centrifugal standby pumps are installed.

Barren solution from the precipitation presses goes to a sump from whence it is pumped to the mill-solution supply tank. Refining of the precipitate is accomplished with a two-muffle Case roasting furnace and a Case tilting-crucible furnace.

The tank-settling area for the thickeners and the capacity of the agitators is calculated for treating 240 tons per 24 hours, but the height of the thickeners has purposely been increased by 2 ft., which will allow for the insertion of a false floor or deck in each tank, which with an additional set of rabble arms on the shafts, will bring the capacity of the thickeners up to 400 tons. Thus if the anticipated increase in production from 200 to 400 tons should have to be met, it will simply require the installation of the necessary agitators, a comparatively small item.

In addition, auxiliaries such as machine shop, blacksmith shop, warehouse and transformer house are built. An incline tramway is installed to haul supplies and construction material for the mine and mill, from the wagon road below.

The buildings are all timber framed and covered with corrugated iron, except the refinery, which is constructed of hollow concrete block walls, steel roof trusses and corrugated iron roof covering. The grinding and cyanide departments have concrete floors sloping ¼ in. per foot where possible and all draining into a sump on the lowest floor.

A comprehensive idea of the total cost of the installation as well as of the individual departments can be had from the attached cost distribution. Taking, for the purpose of comparison with the cost of other cyanide plants, what is generally understood to be part of a milling plant, such as crushing plant, mill proper, and refinery, shops, offices, store houses, assay office, and inclined railroad for distributing purposes, and allowing liberally for extending the cyanide plant to 400 tons capacity, the cost of the plant per ton of ore treated amounts to $520. This, in view of the fact that the mine is located 28 miles from the nearest railroad station and all the material had to be transported by motor truck or wagon, and that the purchasing orders were placed at a time when the various machines and materials were averaging at least 15 per cent above normal, is a very low figure.

The compactness of the plant, including the principal departments, such as crushing, milling and refining, is shown by comparison with two other cyanide plants recently designed by the writer; one 500-ton plant occupies 112 sq. ft. and one 350-ton plant 110 sq. ft. per ton of ore treated, while the United Eastern installation on a basis of 400 tons covers an area of only 70 sq. ft. per ton of ore capacity. The cost per ton treated of the 500-ton mill, with the main mill building being constructed of steel, was $930, while the 350-ton plant of identical construction as the United Eastern cost $681 per ton of ore treated. Both of these mills are situated on branch line railroads and were built at a time when prices of material were normal.

The Spectroscopic Determination of Small Amounts of Lead in Copper*

By C. W. Hill and G. P. Luckey†

The following experiments are the result of the need for a rapid method for the determination of small amounts of lead in copper for use in the factory control of copper refining. On account of delay in securing apparatus and the pressure of other work, the authors have not been able to conduct all of the desirable experiments incident to the problem, but are moved to publish the results of the work accomplished in the hope that others may find use for the method and so improve or modify it that it may be capable of broader application.

APPARATUS

The apparatus used consisted of a vertical arc and a small grating spectroscope, together with suitable resistances and condensing lens, shown diagrammatically in Fig. 1. The arc was formed between an upper negative electrode of half-inch (13 mm.) carbon rod and a small sphere of copper resting in a slight cavity in the lower positive graphite electrode. The spectrum was formed by a 2-in. (5 cm.) concave grating of 3 ft. (90 cm.) focal length ruled 15,000 lines to the inch (6000 per cm.). Lines of the first order spectrum were observed with an eyepiece magnifying ten times. For the determination of lead in copper, the brightest visible line in the lead arc spectrum (405.8 μμ) was observed. This line lies in the violet between the two bright copper lines, 405.29 μμ and 402.29 μμ. Fig. 2 shows the photograph of the spectrum as observed, with the lead and copper lines in prominence and the many fainter lines resulting from the carbon arc.

In later experiments, a rotating upper electrode was used. This steadied the arc materially and held the focus of the arc on the slit, so that the arc required no attention after starting.

PROCEDURE

Weighed samples of copper shot of known lead content were subjected to an arc of constant length and current. By means of a stop-watch the time was measured from the melting of the sample until the disappearance of the lead line in the spectrum. The end-point was easily determined, since the lead line lies almost above the first line of a carbon band. At first the line appears very bright, but as the lead disappears the line assumes the same brightness as the remainder of the carbon band of lines. It is much easier to match the line in brightness than to observe the final disappearance of a line.

OBSERVATIONS

Using the apparatus and method described, experiments were made using varying weights of copper samples (0.1 g. to 1.0 g.) containing different percentages of lead (0.004 to 0.216 per cent). The arc was main-

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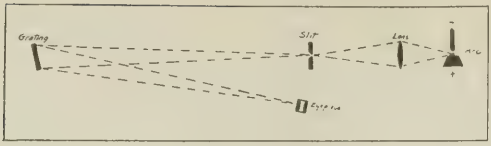

FIG. 1

tained at a length of 0.5 cm. and consumed 10 amp. on a 220 V. circuit. The results are tabulated in Table I.

TABLE I.

Time for Different Weights of Samples.

Per Cent of Lead in Sample	Time in Seconds for Weights of Samples Given					
	0.1 g.	0.2 g.	0.4 g.	0.6 g.	0.8 g.	1.0 g.
0.004	...	14	20	...	...	...
0.005	...	...	...	67	98	150
0.006	...	34	40	...	...	...
0.008	...	50	67	...	...	...
0.059	...	04	...	...	...	...
0.011	22	65	87	135	173	210
0.014	...	67	95	...	...	...
0.016	...	...	120	...	...	...
0.028	...	92	...	215	240	277
0.031	...	...	155	...	...	...
0.045	35	...	180	...	...	...
0.062	50	110	227	...	...	...
0.097	...	203	...	...	...	...

The size of sample which will give the best results is dependent upon the range of lead content to be determined and upon the size of electrodes and current conditions. With a given arc, larger samples increase the accuracy at low percentages of lead, but lengthen the time of measurement for samples of high lead content. For our specific problem and arc arrangement, samples of 0.4 g. are the best.

Table II shows the results of two runs made several months apart, one determination being made with a stationary upper electrode and the other with a rotating electrode. Individual readings are given to show the deviation from the average.

TABLE II.

Check Runs With 0.4 g. Samples.

(Time in Seconds)

Per Cent Lead by Analysis	Stationary Cathode	Rotating Cathode			
		Averages	Individual Readings		
0.004	20	26	25	23	29
0.006	40	...	...	...	...
0.008	67	62	65	60	60
0.011	87	96	100	95	98
0.014	95	110	(From curve)		
0.016	120	120	120	120	120
0.028	146	151	146	155	154
0.031	155	160	(From curve)		
0.045	180	194	(From curve)		
0.062	227	240	235	240	245
0.097	...	313	290	315	334
0.119	...	331	325	329	338
0.156	...	387	375	400	...
0.216	...	474	485	463	...

It is to be noted that the standardization of the method was made by use of factory samples the chemical analysis of which had been made with great rapidity and with the usual errors incident to the method. The readings were taken as a rule at random, with lead content unknown to the person observing the spectrum. Repeated runs by different observers showed variations of the same magnitude as those in Table II.

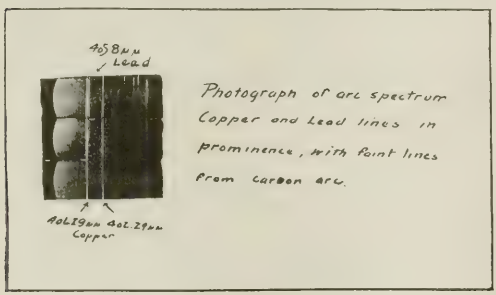

FIG. 2

In using the method as a check on the refining process, it is not necessary to have a complete standardization curve. Samples of satisfactory material may be run from time to time, and the refining process continued until furnace samples show a disappearance time equal to or less than that of the standard sample. If desirable, the disappearance time could be plotted against furnace operating time.

For factory use it is proposed to use a suitable spectroscope, if one can be obtained which has sufficient diffraction to show the lines distinctly. A Joly balance will be substituted for the usual analytical balance, since it is sufficiently accurate and is better adapted to factory usage.

Conclusions

From the above experiments it is concluded that the empirical method outlined permits the rapid determination of small amounts of lead in copper. It is necessary to maintain constant conditions of arc and to standardize the apparatus against known samples. Several check readings should be taken when considerable accuracy is desired.

For control work the time of disappearance of the lead for a satisfactory sample of copper may be used as a standard, and the refining process carried on until the furnace sample shows an equal time of disappearance.

Other Applications

The use of the arc is limited to the determination of small amounts of impurities which are volatilized at a comparatively low temperature in the presence of a metal which is not rapidly volatilized at a comparatively high temperature and which gives a steady arc, the existence of strong characteristic spectrum lines being assumed. (In the present case the above statement should probably be modified so as to apply to the oxides of the metals rather than the metals alone.) Some metals would give better results in an inert atmosphere.

The method might be applied to metals of low boiling point or even to salts, by substituting a heating strip in place of the arc and securing the arc or spark spectrum from the vapors arising from the heating strip.

Illinois Station of the Bureau of Mines

The United States Bureau of Mines has broadened the scope of its station at Urbana, Ill., to include work in coal and metal mining and the metallurgical industries of the Middle West. The present safety work will be continued and all work will be conducted under a cooperative agreement with the mining department of the University of Illinois. The bureau staff is under the superintendence of E. A. Holbrook, supervising mining engineer and metallurgist. Other members are W. B. Plank, in charge of mine safety, and F. K. Ovitz, chemist.

Recent Metallurgical and Chemical Patents

Aniline Oil and Aromatic Amins.—OTTO SCHMIDT and HUGO BLANKENHORN, Germany: Process of producing aromatic amins such as aniline by catalytically hydrogenating aromatic nitro compounds such as nitrobenzene consisting in treating an aromatic nitro compound in the presence of a contact mass, with a gas mixture containing carbon monoxid and at least one volume of water vapor for each three volumes of the carbon monoxid. (1,237,828. Aug. 21, 1917.)

Sulphonic-Acid Salts from Waste Liquors.—A method of treating alcoholic alkaline waste liquors obtained in refining mineral oil is patented by ALBERT WOLFF, of Hamburg, Germany. The waste liquor is treated with dilute sulphuric acid, repeatedly washing the sulphonic acid obtained with dilute sulphuric acid, adding the quantity of alcohol required for dissolving the oil still present, separating the layers thus formed, neutralizing the sulphonic acid solution with sodium carbonate free of water, removing the deposit and evaporating the liquid. (1,240,523, Sept. 18, 1917.)

Lactic Acid.—A process for producing U. S. P. lactic acid from the commercial grade is patented by EDGAR T. OLSON, of Ann Arbor, Mich., and assigned to the Detroit Organic Chemical Co., of Detroit, Mich. The principal claims follow:

"In the process for the production of lactic acid from crude materials, preparing a partially purified calcium lactate, treating the calcium lactate with an aqueous solution of sulfuric acid, thereby producing a mixture containing calcium sulfate and lactic acid, drying said mixture, heating the dried mixture to approximately 130 deg. C., thereby converting the lactic acid into lactid and anhydrid, removing soluble impurities from the resulting mixture, and subjecting the purified mixture to the action of steam, thereby hydrolyzing the lactid and anhydrid to lactic acid and removing the latter in the pure state." (1,240,766, Sept. 18, 1917.)

Urea.—A process of making urea is the subject of two patents of JOHN E. BUCHER, of Coventry, R. I., assigned to the Nitrogen Products Co., of Providence, R. I. An alkali cyanate such as potassium is treated with ammonia, and carbondioxide is passed into the solution. The potassium precipitates out as potassium bicarbonate with the formation of ammonium cyanate, which on heating changes to urea. (1,241,919-20, Oct. 2, 1917.)

Modifying Acetyl-Celluloses.—A process for converting acetyl-celluloses into products easily and viscidly soluble in acetone is patented by E. KNOEVENAGEL, of Heidelberg, Germany, and assigned to Knoll & Co., of Germany.

The process consists in rearranging by heating and in a dissolved or at least strongly swelled state, acetyl celluloses which are insoluble in acetone. This conversion may be carried out in the presence of disintegrating catalysts possessing a weak hydrolyzing action, such as sulphites, bisulphites, chlorides or nitrates with on (in the absence of acid anhydrids) without the presence of water or even by water alone without a catalyst. In the presence of acid anhydrids the water may be replaced by other substances which decompose acid anhydrids, such as alcohol, glycerin, etc. The process is based upon the new knowledge that the saponification and still more the hydrolytic decomposition of acetyl cellulose must take place at the very most to a slight degree only in the transformation of acetyl celluloses insoluble in acetone into products soluble in acetone, if valuable acetyl-celluloses viscidly soluble in acetone are to be obtained. (1,241,995, Oct. 2, 1917.)

Ethyl Chloride.—B. S. LACY, of Sewaren, N. J., patents a process for making ethyl chloride. The patent is assigned to the Roessler & Hasslacher Chemical Co., of New York.

The process consists in mixing chlorine gas with not less than about three times its volume of ethane, exposing said gas mixture to a temperature of approximately 300-550 deg. C., washing the obtained reaction gases with water to remove the hydrochloric acid gas, separating the ethyl-chloride from the unusual ethane by compressing the mixture to a pressure not exceeding about fourteen atmospheres, drying the gas mixture while in the compressed state and cooling the mixture in the compressed state to about —20 deg. C. (1,242,-208, Oct. 9, 1917.)

Celluloid Substitute.—HENRY DREYFUS, Basel, Switzerland. Production of celluloid substitutes by the employment of a mixture of trichlorethylene and alcohol, as a solvent for certain particular cellulose acetates soluble therein, to which camphor substitutes may be added. The new celluloid substitutes are claimed to be free from certain so-called objectionable features possessed by celluloid and by many of the celluloid substitutes heretofore employed, in particular, the objections of being brittle, non-transparent and unstable. The solution of the cellulose acetates, with or without camphor substitutes, in the mixture of trichlorethylene and alcohol, can also be employed for varnishes, coatings and the like, and for the manufacture of films. (1,242,-783, Oct. 9, 1917.)

Various Chemical Processes

Thickening Solutions and Emulsions.—PAUL ASKENASY, Karlsruhe, Germany. When cakes of pulverized gelatin are placed in a liquid, such as milk, for example, a thickened deposit of the liquid is obtained, as the water contained therein will be absorbed by the gelatin. The swollen gelatin, which heretofore was only used in form of cakes, leaves or powder, however, had the disadvantage that its several particles would stick together, whereby the separation of the liquid, and in particular the drying and renewed employment of the gelatin matter was rendered difficult. According to the present invention the gelatin is employed in form of balls, globules, beads, polyhedrons and in general of a form which is between a ball and a cube. It has been found that when gelatin of such form is used the gelatin particles, even during the drying process, will not stick very much together. (1,234,714, July 31, 1917.)

Dry Distillation of Cellulose Materials.—H. VON HOCHSTETTER, Constance, Germany. Observation has been made that the yield of acetate of lime in wood distillation undergoes a considerable increase if the charring period proper (the period of self-charring) be made as short as possible; *i.e.*, that as soon as one notices any sign of an exothermic reaction taking place within the retort the supply of heat is so considerably and forcefully increased that from this time on the temperature prevailing in the retort for the further run of the distillation is about 400 deg. centigrade or higher. (1,241,789, Oct. 2, 1917.)

Removing Combined Sulphur from Rubber.—David Spence, Norwalk, Conn. The process consists in subjecting the vulcanized rubber in solution to the action of anhydrous caustic alkali in a finely divided state at a suitable temperature and under conditions of agitation adding a suitable quantity of an acid to neutralize the alkaline ingredients remaining in the solution, and precipitating the rubber from the solution. (1,235,852, Aug. 7, 1917.)

Pyroxylin Composition.—Walter E. Masland of Philadelphia, Pa., has patented a pyroxylin composition containing aldol and especially applicable to the production of compositions for making coated fabrics. The patent is assigned to the du Pont Powder Company. One example of the composition contains twenty parts pyroxylin, eighteen parts aldol, fifty-two parts castor oil, a pigment and a volatile solvent, the volatile solvent being from two to four times the weight of the remainder of the whole composition, and the solvent being comprised of about sixty parts benzol, thirty parts alcohol and ten parts commercial ethyl acetate. (1,234,921, July 31, 1917.)

Phenol Condensation Products.—Konstantin Tarassof of Dobroslobodsky, Russia, has patented a process for making phenol condensation products by causing phenol, formaldehyde, sulfonated resin oil and sulfo-acids obtained by treating crude petroleum with sulphuric acid, to react together. (1,235,507, July 31, 1917.)

Cellulose.—A new cellulose compound is patented by Emile Léon Bloch-Pimenthel of Paris, France. The process comprises treating cellulose with formic aldehyde and ferric chloride, drying in vacuum and heated in an oven sufficiently to form trioxymethylene, and cause same to react with the cellulose and ferric chloride. (1,234,720, July 31, 1917.)

Acetyl-Cellulose.—Acetyl-cellulose and the process of making same is the subject of two patents of William G. Lindsay of Newark, N. J., assigned to the Celluloid Company. The object is to accomplish acetylation of the cellulose in fibrous form without solution of the cellulose and without the use of sulphuric acid, sulfo-acids, or other constituents tending to induce decomposition. The cellulose is given a preliminary treatment with acetic acid and zinc chloride, and then subjected to the acetylating bath, which consists of acetic anhydride and benzene. (1,236,578-9, Aug. 14, 1917.)

Treatment of Sulfite Liquor.—A process of precipitating organic substances in sulfite liquors is patented by Hans Brun Landmark of Drammen, Norway. It is accomplished with sulfuric acid produced by oxidation of SO_2 in solution with an electric discharge. (1,236,948, Aug. 14, 1917.)

Alcohols.—Oskar Matter of Cologne, Germany, has patented a method of manufacturing polyvalent alcohols. The method consists of heating a chlorinated hydrocarbon in a closed vessel in the presence of alkali bicarbonate and copper, the amount of water highly exceeding that of unaltered chlorinated hydrocarbon present. (1,237,076, Aug. 14, 1917.)

Increasing Catalytic Action.—The use of atinic rays for increasing catalytic action is the subject of a patent of Frederick G. Keyes, assigned to Cooper-Hewitt Electric Company of Hoboken, N. J. The method consists in subjecting a reaction mixture to atinic rays from a source which generates more heat than desired for the reaction, and protects the reaction mixtures by a vacuum chamber interposed between the source and the mixture. (1,237,652, Aug. 21, 1917.)

Synopsis of Recent Metallurgical and Chemical Literature

Gold and Silver

Precipitation and Smelting at the Great Fingall Mine, Western Australia.—In the monthly *Journal* of the Chamber of Mines of Western Australia for July, 1917, Mr. W. B. Chomley describes the methods used at the above property. For an average month when the tonnage treated was 4220, the cost was 14.44 cents per ton of ore treated.

Of the tonnage milled some 66 per cent is treated as sand by leaching, and the remainder as slime by decantation. The solutions are precipitated together. Approximately 300 tons of solution is passed through the boxes every 24 hours having a cyanide strength of 0.04 per cent KCN and an alkalinity of 0.015 CaO. The head value of the solution entering the boxes has an average value of 5s. to 7s. ($1.20 to $1.70), and the tails vary from 0.2s. to 0.5s. (5 cents to 12 cents). The former (0.2) appears to be the limit to which the gold in the solution can be reduced, and it is admitted that this figure might be improved upon by some more active precipitant than zinc, or some other form than shavings.

The precipitation boxes—of which four are kept in use—are built of wood, and are considerably larger than those installed on most mines in this state. Each has seven compartments with a capacity of 16 cu. ft., but only five compartments are in use. This makes a total of 320 cu. ft., or 1 cu. ft. (approximately) per ton of solution per 24 hours. Each compartment holds about 120 lb. of new teased zinc shavings, or slightly more of old zinc than has been in use some days. An even and equal flow of solution is maintained through the boxes by having a suitable reducer on the end of each delivery pipe. All the feed pipes draw from one trough, which has an overflow leading back to the mill circuit.

The boxes are cleaned up twice a month, and the zinc is moved up once between clean-ups. At the mid-monthly clean-up the zinc is only washed and returned to the boxes after the sludge is removed. Frequent tests have demonstrated this intermediate clean-up to be necessary to maintain good precipitation.

The addition of lead acetate has been tried at various times and in various ways, but results have failed to show that it exerted any beneficial effect. Experience has proved that, so long as the cyanide strength is maintained above 0.03 KCN and no sudden drop in the alkalinity takes place, the box tail values entirely depend upon the ratio of solution flow to zinc area. When overloading takes place, the falling off in precipitation is not simply in proportion to the increased flow, but is very much greater. Cases have been observed where the tails of one box have risen to ten times the value of its neighbors, and the cause has been traced to an accident which increased its flow apparently not more than 50 per cent, and on this being rectified they fell to normal without any addition or moving of the zinc.

At the month-end clean-up only the very short zinc

is dissolved, but all the rich zinc which is strong enough to be of further use is soaked in dilute sulphuric acid, and is subsequently scrubbed and returned to the boxes. For this purpose a spare precipitation box is used. The compartments of this are partly filled with a solution of about 5 per cent H_2SO_4. The zinc after having been roughly washed in its own solution is placed in the acid and left to soak for several hours. When the adhering gold slime has been loosened sufficiently to permit of its being easily rubbed off, the acid is washed away by running a stream of water through the box, and the zinc can then be handled without inconvenience. Some gold always remains on the zinc, which usually assays about 0.04 per cent or 5s. ($1.20) per pound after being washed, while the gold removed by this process amounts to from five to ten times that value.

The slime consists of a 20-in. ten-frame press. Formerly this was filled by air pressure from a monteju, but this has been discarded in favor of a vacuum pump. The delivery ports of the press have been altered to connect with the suction of the pump, while the intake of the press connects with a pipe line having suitable connections opposite each acid tub and precipitation box. To these connections can be attached a length of hose fitted with a scrim-covered funnel, which can be dropped into one compartment to remove the sludge while washing is proceeding in another compartment. After the press has been used on "cyanide" slime, and before it is used for "acid" slime, it is an invariable rule to give it a water wash to remove traces of cyanide from the cloths. If this is not done the acid, in coming in contact with the cyanide, will form various gelatinous compounds which retard filtration. This method of using a closed filter in conjunction with a vacuum pump has several advantages over both the ordinary pressure filter and the open-leaf vacuum filter. Unlike the former, it does not blow out when a leak occurs, and at the end of the clean-up there is no slime left behind in the monteju, which usually can only be recovered at the cost of some time and labor. The low pressure obtained by a vacuum is compensated by the saving in time through being able to operate the filter continuously until full, instead of intermittently, as is the case when using air pressure. It has an advantage over the open vacuum filter inasmuch as the cakes can be dried by air pressure and delivered in a convenient form. Over both it has the advantage of being able to collect the sludge and cloudy solution from the boxes and deliver the slime ready for roasting without intermediate handling.

The slime is roasted on trays in a reverberatory furnace, fluxed with 40 per cent of borax and 15 per cent of sand and smelted in crucibles in well furnaces. Formerly a tilting furnace was used, but abandoned owing to the small amount of slime to be smelted. The smelted bullion has an average fineness of 760.

Flotation

Mt. Lyell Company's Flotation Plant.—One of the most recent installations of the flotation process is that of the Mt. Lyell M. & R. Co., Queenstown, Tasmania. As described in the *Mining and Engineering Review*, September, 1917, the treatment plant is one of the most up-to-date and compact of its size in the commonwealth. The ore contains chalcopyrite and pyrites finely disseminated in a schisty gangue. The average mineral content is about 3 per cent copper, 0.2 oz. silver and about 0.5 dwt. gold.

The flotation plant was started on Feb. 17, 1916, and the tonnage treated up to Mar. 31, 1917, was 17,027 tons, of which 3530 tons was low-grade ore. The crude ore is tipped in a bin of 150 tons capacity, fed over a grizzly into a jaw crusher and reduced to 2 in. The crushed material is then elevated to a rubber belt conveyor which delivers into two fine-ore bins. From here it is fed by means of roller feeders on to submerged shaking screens of ⅛-in. diameter; the oversize from the screens passes through two sets of crushing rolls, thence on to an elevator and back on to the shaking screens. Finally the whole of the material passes through the screens, is elevated, passes an automatic sampler from which the daily crude ore sample is obtained, and is delivered into a diaphragm cone classifier, 5 ft. in diameter by 6 ft. 6 in. deep, with a diaphragm 6½ in. in diameter, near the bottom, leaving an inch and a half annular opening. This classifier separates the sands from the slime.

The slime overflows to two Dorr thickeners, 20 ft. in diameter and 10 ft. deep. The discharge from the classifier is divided between two tube mills 16 ft. 5 in. long and 5 ft. diameter, revolving at the rate of 29 r.p.m. The mills are equipped with scoop feeders and are motor driven through gears. The discharge from the tube mill joins the Dorr thickener discharge and is elevated into the minerals separation flotation boxes of standard size having 18-in. impellers revolving at the rate of 320 r.p.m. There is a series of twelve mixing boxes with corresponding spitz or flotation boxes. Eucalyptus oil is sometimes added to the mixing boxes, but usually to the tube mills. The consumption of oil is slightly less than ¾ lb. to the ton of ore treated. Oil costs about 8d. (16 cents) per pound. The tailings from the minerals separation boxes flow direct to the dam.

A feature of the process is that no return water could be used on account of the excessive sliming of the gangue in the ore. The fine concentrates are at present being re-treated in a simple apparatus designed by the local staff, with considerable improvement in grade.

The final concentrate is elevated into steel settling tanks 20 ft. diameter and 8 ft. deep, provided with filter bottoms and with vacuum pumps attached. The concentrates are shipped from these tanks in trucks to the sintering plant. An Oliver continuous filter is being erected for the continuous filtering of the concentrates.

The whole plant is driven by independent motors, is extremely flexible, and has a capacity of 250 tons a day when running three shifts. At present only one shift is being run, and that intermittently on account of the irregular ore supply.

Canadian Wood Oils for Flotation.—A series of tests on Canadian wood oils and their use in flotation on cobalt ores is described in the *Canadian Chemical Journal* for November, 1917. The authors are R. E. GILMORE and C. S. PARSONS, the former in the Forest Products Laboratories of Canada and the latter in the Ore Dressing Division of the Mines Branch. The collecting of the wood oils was planned and carried out by the Forest Products Laboratories and the flotation tests were made by the Mines Branch. On account of the diffi-

culty which the flotation plants, the number of which was rapidly growing, reported in obtaining an adequate supply of imported pine oil, it was decided to investigate the possibilities of either finding a substitute for pine oil which was found necessary as a selective frothing oil, or of producing a satisfactory grade of pine oil in sufficient quantities from Canadian resinous wood waste. A large number of oils was collected and tested, including pine oils and creosote oils from the United States.

Among the first series of oils tried out were the original crude oils as collected. A sample of the total distillate, being the combined fractions from a distillation run, was in each case saved and tried out to see if the removal of free carbon and heavy pitch or coke residue from the oil improved its flotation value.

Individual fractions and groups of fractions were saved for the purpose of finding out just what part of a crude oil was of most flotation value.

Preliminary chemical separations of the hardwood creosote oils into neutral and acidic (phenolic and creosotic) constituents were carried out and the respective flotation values of these two group separates tried out.

A description of all the oils submitted for flotation tests is given in a table. Judging from actual flotation results for cobalt ore the use of steam distilled pine oil is to be recommended by the authors in preference to the destructive distillation grades, and graded specifications approaching 95 per cent distilling between 190 deg. C. and 220 deg. C. with the proper specific gravity range seem worthy of consideration in buying pine oil for flotation purposes. A pure pine oil is not always necessary for flotation purposes, but in using destructive distillation grades their value appears to be in direct proportion to the pine oil content as defined above.

In Canada the most promising resinous wood materials are the red (Norway) pine stumps of Northern Ontario and the western yellow pine stumps of British Columbia. The old stumps from ten to twenty years after felling the tree in many cases have sound hearts rich in oleoresin. Although the rosin content is high, the yield of wood turpentine is only fair and the proportion of true pine oil is small compared with the standard species, longleaf southern pine. In the Southern States the yield of pure pine oil is 2 3-5 United States gallons per cord of about 4000 pounds from the best grades of resinous wood waste. From the above Canadian woods the crude pine oil fraction, containing more or less "light oil" distilling between turpentine and pine oil proper, amounts to about 4 Imperial gallons per 2600 pounds cord and only a small proportion of this can be considered as true pine oil. By using two or three times the usual quantity of the sample, fairly satisfactory flotation results were obtained. All attempts to utilize the whole crude oil distillate or its turpentine or rosin oil content met with failure in this investigation. As pine oil is essentially a by-product of turpentine and rosin recovery from resinous wood waste and as this recovery industry has not yet shown prospect of profitable establishment in Canada, there is little promise of obtaining a commercial supply of frothing oil suitable for cobalt ores from Canadian resinous wood waste. In this connection the recent statement of Professor H. K. Benson of the University of Washington, who has investigated wood waste industries for the United States Government, is significant, viz.: "The commercial status of the softwood distillation industry is unsatisfactory in the Pacific States, in the Michigan and in the Wisconsin districts." However, considerable commercial progress has recently been made in the Southern States on richer material after a series of failures, and it is to be hoped that technical investigation will in time place the whole resinous wood industry on a sound commercial basis.

In discussing hardwood oils as substitutes for pine oil the authors point out that hardwood creosote oils can be drawn off separately as crude oils in the process of refining the wood alcohol and acetic acid. The indications are that they can be used as frothing oils in place of pine oil. While the yield per cord is about the same as for pine oil from longleaf Southern pine, the supply is comparatively large, there being over 500 cords of hardwood distilled daily in Canada at present and over ten times this amount in the United States, mostly in the border states.

Other hardwood oils mentioned are heavy yellow ketone oil and ketone residue, by-products of the manufacture of acetone from gray acetate of lime. While the yellow ketone oil is already of considerable value in the industries, its value as a flotation frothing oil is important especially in an alkaline pulp where it gives a high grade concentrate. Ketone residue, which is black and syrupy in nature, is produced in fairly large quantities and has noticeable collector values, as well as being a good frothing agent. This oil deserves more attention, the authors say, not only for cobalt ores, but for use alone with other ores, where it has very promising qualities.

Miscellaneous

Calcium Silicates as Fertilizers.—At the meeting of the American Chemical Society in Boston, in September, Alfred H. Cowles presented some interesting data on calcium silicates and their use in supplying lime and soluble silica for plant growth. The author presented a paper at the Eighth International Congress of Applied Chemistry describing a method of manufacturing alumina, hydrochloric acid, caustic alkalies and a white hydraulic cement from salt, clay and lime. (See this journal Oct., 1912, for a complete description.) In that paper was explained how an artificial alkali-alumina-silicate could be produced and how, by grinding it with the proper amount of lime and passing the mixture through a rotary furnace, a sinter could be formed that would have the following composition, provided the temperature of the furnace was not so high as to volatilize the alkali constituent:

Dicalcium silicate Dialkali aluminate

$$x[(CaO)_2SiO_2] + 1[(Na_2O)_2Al_2O_3]$$

Here we have the disodium aluminate, a very soluble compound in water, and the x molecules of dicalcium silicate, an insoluble compound in *pure* water. Therefore, it was explained, that by leaching, the dialkali aluminate could be almost completely separated leaving dicalcium silicate as a residual product. From this, it was proposed to produce a cement. This treatment of a proper mixture of silicates with lime and soda carbonate to produce the above product is covered by a patent issued to Adolf Kayser which patent is owned by The Electric Smelting & Aluminum Company of which the author is president. He did not, therefore, feel jus-

tified in mentioning an unpatented improvement (patents are now pending), namely, that the product could be so made and still the leaching be effectively performed with the alkali metal oxide ratio to alumina as low as one and twenty-five hundredths (1.25) molecules of alkali to one of alumina in the sinter. Under these conditions he had discovered that he could leach as high as eighty-five and three-tenths (85.3) per cent of all the alumina away from such a sinter, leaving the dicalcium silicate with some alumina and a little soda in the residue. This proved that fusion or sintering could be effected at a low enough temperature to prevent loss of potash, and that such minerals as potash feldspar and potash mica schists could be treated with the right amount of lime to form dicalcium silicate, and a calcium aluminate with liberation of potash which would be available as a fertilizer. Very encouraging experiments with impure potash feldspar had been made.

The following remark occurred in the paper:

> This process also furnishes a key to unlock the stores of potash from the world's mountainous masses of feldspar.

At the time of that paper, lime was known to be of value as a fertilizer, silica was known to be present in large amounts in the skeletons of all plants, but he did not know that soluble silica had been discarded as an essential fertilizer by plant physiologists.

The author had made experiments which showed that limes made a great improvement in the growth of plants over the native soil and that the dicalcium silicate or calcium hydrate plus hydrated silica showed a very marked gain in luxuriance of growth over the lime treated soils. The author then gives a long discussion and cites experiments showing that soluble silica such as furnished by this silicate is an essential fertilizer and it renders available tremendous resources of native raw materials from which to produce fertilizers. In an addenda to the International Congress paper he also states that all obstacles to the eventual complete success of the manufacturing process have been surmounted at his plant in Sewaren, N. J.

Scientific Management in the French Chemical Industry.—A writer in a recent issue of *La Revue des produits chimiques*, according to the *Chemical Trade Journal* (London), observes that the Taylor system, as generally understood, can only be applied in industries the manual work of which admits of easy analysis into simple and continuous movements, or "rhythmic periodicity." That is to say, it is chiefly applicable in mechanical or engineering industries and to a much less extent, if at all, in the chemical industries. This, however, does not preclude the possibilities of applying to the chemical industries the principles of scientific organization in the best and widest sense of that term. Taylor's system is merely an application of the Cartesian analysis. The author of the system was a good analyst but a bad synthesist, and in building up his system he overlooked the unity of control and inter-relation and co-ordination of the different parts of a whole which are supremely essential. In the chemical industries it is the man more than the system which counts, and so far as France, at all events, is concerned, it is confidently hoped that, notwithstanding the ravages of the war, there will still be plenty of men able to lead and to organize.

The chief point of the article referred to is, however, the pressing need for educated and skilled workmen—not necessarily men trained according to the Taylor plan, which, as already noted, is hardly applicable, but men of trained intelligence, or, in other words, what the author calls "professional workmen." The great weakness of the French chemical industry, says the writer, is that the number of properly trained workmen is lamentably small. This is due to a variety of causes, of which the chief are the decline of the apprentice system, the absence of suitable means of instruction and training, and the "deplorable policy of the trade unions."

Motti and Fourmond, in a book recently published in Paris by La Société d'Etudes Economiques et Sociales, have determined by experiments that 100 average workmen are only able to do the work of 65 properly trained men, representing a loss by inefficiency of 35 per cent. The disastrous consequences of this to the employer, to the workmen, and to the community in general need no emphasis. According to French official statistics, the number of students passing through commercial and technical institutes in France per annum is about 35,000, as compared with 500,000 in Germany. The number of persons engaged in commerce and industry in France is estimated at 9,300,000, and the number of young persons under 18 years of age is about 850,000. It follows from this that the greater part of the persons employed in industry are very imperfectly trained. The position is still worse in regard to agriculture.

It is necessary to reform the whole educational system of the country and to aim at producing trained men of action rather than academicians.

A Portable Belt Conveyor

A portable belt conveyor which appears to have many uses has recently been developed by the Barber-Greene Company, Aurora, Ill. Two illustrations of different types of this conveyor are shown in Figs. 1 and 2.

The most extensive use of this conveyor is for handling coal, especially in unloading cars to bins or open piles. It is also being used, however, for handling other materials such as clay, brick, crushed stone, salt, etc. In the case of salt and chemicals injurious to steel, a wood frame is furnished with the conveyor.

All of the conveyors are self-contained with the electric motor mounted within the conveyor frame. In this way, the one machine can be applied to a variety of conditions with very little difficulty in moving from one

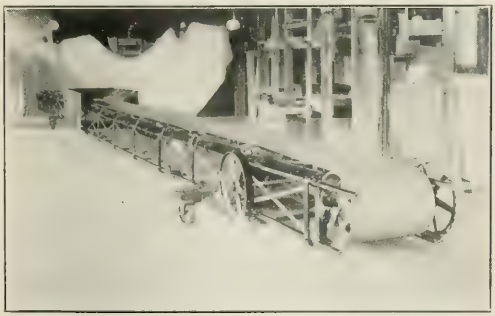

FIG. 1. PORTABLE BELT CONVEYOR FOR WAREHOUSE USE

FIG. 2. HANDLING LUMP COAL TO OUTSIDE PILES

operating position to another. A special type of frame construction is employed which has been found to be more than ample for all requirements to which it has been applied, and at the same time is sufficiently light to make the conveyor really portable.

In some cases, material is shoveled into the conveyor hopper and discharged over the other end onto the pile or into another conveyor. In other cases it is possible to let the material flow by gravity into the conveyor hopper and the material is thus transferred with little or no manual labor.

Fig. 1 shows a conveyor for warehouse use. The discharge end may be fixed to any desired height and frequently is arranged with height sufficient to discharge in a hopper of a similar conveyor. The hopper may be set at any point on the conveyor convenient for the workmen or the conveyor may be provided with a continuous hopper. Fig. 2 shows a conveyor handling lump coal to outside piles.

Some Substitutes for Platinum Ware

By Roy Franklin Heath*

The great increase of the value of platinum during the past few years has warranted the production of many substitutes. Many of these substitutes are successful, but their use is limited. By careful limitation of the work to be done by each of these substitutes, it is possible to do away entirely with platinum crucibles. At the present time it is not only right, but patriotic that there be a less demand of platinum ware from laboratories which can do away with the use of this substance without impairing results and at the same time at less expense.

The substitutes to be considered here are gold, silver, nickel, composition and fused quartz. Each of these have uses, some of which are very limited. The first four named will stand a harder usage than platinum crucibles of good quality, while fused quartz answers many purposes, but requires greater care in handling.

EFFECT OF HEAT ON THE CRUCIBLES

The effect of heat on these crucibles is interesting. This test was carried out by heating the weighed crucible in the direct Bunsen flame tip for a period of 32 hours. They were then cooled and weighed. The differences in weight were noted and were as follows:

Crucible	Original Weight	Weight After Heating	Loss or Gain
Platinum	26.100	26.138	.038
Gold, pure	19.261	19.263	.002
Silver, pure	24.536	24.540	.004
Nickel	32.560	32.559	.001
Composition	28.920	28.923	.003
Fused quartz	28.102	28.100	.002

SOLUBILITY IN ACIDS

The solubility of the various crucibles in concentrated acids were tested. In conducting these tests the crucibles were first cleaned with sand, washed, dried and weighed. They were then immersed for a period of thirty minutes in the acid, washed with water, dried, weighed and the difference in weight noted.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	30.02	30.019	.001
Gold, pure	25.061	25.051	.010
Silver, pure	32.503	32.495	.008
Nickel, wrought	34.265	34.141	.124
Composition	31.180	31.176	.004
Fused quartz	27.901	27.899	.002

Hydrochloric acid.
Specific gravity, 1.2.
Time, 30 minutes.
Temperature, 18.5 deg. C.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	31.680	31.680	.000
Gold, pure	26.753	26.751	.002
Silver, pure	33.568	33.462	.106
Nickel, spun	32.552	32.493	.059
Composition	31.002	31.000	.002
Fused quartz	29.690	29.687	.003

Sulphuric acid.
Specific gravity, 1.84.
Time, 30 minutes.
Temperature, 18.5 deg. C.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	30.065	30.064	.001
Gold, pure	26.890	26.886	.004
Composition	31.567	31.565	.006
Fused quartz	29.736	29.732	.004

Nitric acid.
Specific gravity, 1.42.
Time, 30 minutes.
Temperature, 18.5 deg. C.

As a substitute for solid platinum ware there is on the market a platinum clad wire and platinum plated ware. This substitute answers the purpose very well for the time being and at a cost of about one sixth the original cost of the solid goods. The lasting qualities of this platinum plated ware is well known. It is well to remember that nascent chlorine, iodine and bromine attack platinum. Fusions containing sodium, potassium, or barium hydroxides should not be effected in platinum or platinum clad ware.

Nickel ware or crucibles can take the place of platinum in electrolytic analyses and other operations where strong acids are absent. Nitric and sulphuric acids are its solvents and should not be present. It can be used in igniting and weighing operations, but it is not advisable to make alkaline fusions in nickel vessels.

Gold crucibles and ware make a good substitute where a high temperature is not needed. Being nearly insoluble in acids and forming no compounds with alkaline hydroxides they are useful in making fusions which cannot be made in platinum vessels. However, gold is attacked when free chlorine, bromine or iodine are liberated. It is more stable in the rough flame than platinum and does not combine with carbon. It can be used in making fusions (not alloy), as the anode and cathode in electrolysis, drying, igniting and weighing. As it melts around 1000 deg. C. care should be taken in heating.

Silver has more uses in the laboratory as a plating agent than in ware. Silver crucibles are attacked by

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nitric, hot sulphuric, the nascent halogens, sulphur fumes and sulphur. It is not attacked by the alkaline carbonates or hydroxides and is used for their fusions and solutions. It can also be used in weighing, ignition, etc.

Fused quartz can be used in making fusions where any of the halogens are liberated. It is not attacked by any acid except hydrofluoric. It has a high fusion point (around 1700 deg. C.) It can be used in general laboratory work, ignitions, fusions, weighing, etc., etc.

A composition ware composed of Canadium I part, palladium I part, platinum 2 parts, and nickel 6 parts, makes an excellent substitute for platinum. Ware and crucibles made from this alloy have been in use, in the writer's laboratory for a period of eight months, with satisfactory results. Its fusion point is around 1570 deg. C., it is not readily attacked by any single acid, but nitric acid attacks it most. It is attacked by the halogens, and the same care should be observed with this ware as if it were of platinum.

As a general laboratory ware, in crucibles, and as anode and cathodes in electrolyses this alloy can be used with success and seems to be a perfect substitute for platinum at about one-half the cost.

Protective Treatments for Cement Floors Subjected to Injurious Liquids

By W. P. Anderson

President, The Ferro Concrete Construction Co.

The Ferro Concrete Construction Company has been making a series of tests to determine the best treatments for concrete floors that are subject to harmful liquids.

Sixty concrete slabs were made, 21" square and about 1" thick. There were 6 different kinds made, 10 of each kind.

The aggregate was composed of Lehigh Portland Cement, coarse Bank finish sand, and Ohio River pebbles ranging in size from about ¼" to ½". These pebbles are hard rock, mostly flint. Just sufficient water was used to make the finish work properly. The six different kinds of slabs were made as follows:

No. 1. 1 part cement, 1 part sand, 1 part pebbles; the finish surface being kept moist for 10 days after being made.

No. 2. 1 part cement, 1⅞ parts pebbles; the finish surface being kept moist for 10 days after being made.

No. 3. 1 part cement, 2 parts sand; the finish surface being kept moist for 10 days after being made.

No. 4. 1 part cement, 1 part sand, 1 part pebbles; the finish being exposed to the sun and not kept moist.

No. 5. 1 part cement, 1⅞ part pebbles; the finish being exposed to the sun and not kept moist.

No. 6. 1 part cement, 2 parts sand; the finish being exposed to the sun and not kept moist.

The first three kinds had a little rim around the edges on the finished side so that liquids could be retained on the surface. This was neglected in the last three kinds so when being tested an edge was formed with plaster of Paris. After the slabs had cured about two months, each was divided into 25 3-in. squares, with a 1-in. space between each square. This is shown in Fig. 1. The squares were lettered from *A* to *Y*, each slab being treated in the same manner with liquid hardeners, protective paints, etc., a different kind being used in each square.

A, B, C, D, E, F, G, H, K, L were chemical hardeners; *I, T* and *X* were oil hardeners; *M* was linseed oil; *J, N, O, Q, R* and *W* were paints; *P* and *V* were blank acid-proof coatings; *U* was a liquid preservative, *Y* was paraffine, and *S* was a cement floor filler, no paint being added.

A was applied by brushing in with a tooth-brush, the first treatment being 1 part hardener and 1 part water. The surface was kept well flooded, and the scum which came to the surface was scraped off after it became thick. A second coat of the same strength was applied. After the scum was removed, a third full-strength treatment was applied. This was repeated several times, the last being a hot full-strength solution on the lower half of the square.

B, H and *L* were treated like *A* except that the first coat was 1 part hardener and 2 parts water. The second application was 1 part hardener and 1 part water. The third application was 2 parts hardener and 1 part water; sufficient time being allowed to elapse between each application so the floor would be thoroughly dried.

C, F and *G* were applied like *A*.

D was applied like *B* except the first treatment was 1 part hardener, 4 parts water; second treatment, 1 part hardener, 2 parts water, and third treatment, 2 parts hardener and 3 parts water.

E was applied by brushing on one coat of full strength and rubbing off the surface in about 10 minutes.

I was brushed on, allowed to dry and again brushed on, about three coatings being applied.

J was applied in two thin coats, no filler having been previously used.

K was applied like *A* except hot coat was omitted.

M, linseed oil was applied with first coat, 55 per cent turpentine and 45 per cent oil; second coal, 8 parts oil and 7 parts turpentine; third coat, 2 parts oil and 1 part turpentine; fourth coat, straight oil.

N, two coats of floor filler were first applied, followed by a finish coat of paint on the lower half of square.

O, P, Q and *V* were applied in two coats with a third coat on the lower half of the square, no filler being used.

R received one coat of filler and a finish coat of paint and second coat of paint on lower half.

S was applied in two coats at intervals of 24 hours. An extra coat was applied on bottom half of square.

T, U and *X* were applied in three coats.

W, one coat of filler, then one coat paint, and then an extra coat of paint on lower half.

Y, paraffine was heated to a liquid and floor was heated by a blow-torch, the liquid paraffine being run over the surface.

The liquid hardeners appeared to be water solutions of aluminium sulphate, the percentage of the latter being about as follows: *H* 35 per cent, *E* 25 per cent, *D* 24 per cent, *G* 20 per cent, *B* 18 per cent, *L* 17 per cent, *K* 16 per cent, *F* 6 per cent, *A* 4 per cent. These hardeners caused a white scum to occur in varying amounts, the order being about as follows, starting with the one causing the most scum: *A, E, L, F, D, K, C, H, G, B*, the first four causing much more scum than the last six.

The acetic acid used was 55 per cent commercial acid and the other acids were as follows: Commercial sul-

phuric acid, nitric acid 38 deg., commercial hydrochloric acid. The acetic and sulphuric acids, when put on full strength, caused a heavy scum to occur which was washed off before a second treatment, and in all cases two or three treatments of the liquids were used, so that the surface was kept wet for several days. In some instances they dried, however, between applications.

Two applications of sweet milk were applied, the milk being allowed to sour. The first application may have been eaten by a cat as no scum was left, which was the case with the second application.

The sugar solution contained about 1 lb. of sugar to a gallon of water.

The strong acetic acid caused the surface of the concrete to become soft until down below the action of the acid, which was possibly 1/32 in. The action of the strong sulphuric acid removed all visible traces of all the protective applications, and acted uniformly over the entire surface of the test piece. After removing the scum and washing, the surface was soft for a very thin film and very hard under this. The sand did not seem to be loosened, which was the case with the acetic acid, the surface being much smoother with the sulphuric than with the acetic. The hydrochloric and nitric acids left the concrete comparatively soft, about like strong acetic, but took the cement away between the grains of sand and pebbles, leaving a rough surface. The weak sulphuric acid left the surface of the concrete fairly hard. The strong acetic acid caused violent action, leaving a quantity of powder. The strong sulphuric acid also caused violent action, leaving a scum on the surface.

Those specimens treated with strong hydrochloric or nitric acid left the surface of the concrete damp after an elapse of two months. The strong nitric acids seemed to soften up the paints. The milk seemed to have very slight, if any, action on the concrete but tended to soften up the paints, so it would not be advisable to put paint on concrete floors which are apt to come in contact with sour milk.

The sugar solution apparently caused no action on any of the test pieces, the concrete apparently not being affected.

The tests indicate that some of the liquid hardeners and floor paints on the market afford good protection to floors subjected to dilute hydrochloric or dilute acetic acid, and to a lesser extent with dilute nitric or sulphuric acid. Certain paints and cement fillers give good protection against strong hydrochloric; which is not the case with liquid hardeners. Cement floors should not be used where strong sulphuric acid will come in contact with them. Some of the paints and hardeners seem to be much better than others for certain purposes, and will give a certain amount of protection even against strong acetic acid. The sour milk was probably not long enough in contact with the concrete to show what action would occur.

The kind of finish did not seem to have any appreciable effect. However, from experience in actual buildings, I would recommend a mixture of: one part cement, one part coarse sand and one part hard pebbles or crushed hard rock, and would avoid using coarse pebbles without sand mixed with them.

Cincinnati, Ohio.

FIG. 1. SQUARES OF CEMENT UNDER TEST

Alcohol for Motor Fuel in Australia

The London *Times*, Engineering Supplement, Sept. 28, 1917, prints a summary of a report of the special committee appointed by the Commonwealth Advisory Committee of Science and Industry in Australia to investigate the subject of alcohol as a motor fuel. Also a report written by Mr. W. T. Rowe, the chemist to the South Australian Department of Chemistry, and published as Bulletin No. 8 of that department. These reports run on closely similar lines, the main aspects of the problem with which they deal being the design and manufacture of the engine, the supply of alcohol, and the methods of denaturation.

The committee, like Mr. Rowe, begin with a discussion of the advantages of alcohol as a fuel for internal combustion engines, and proceed to explain the reasons that have decided them to devote their attention primarily to the design and manufacture of stationary rather than motor-car engines. They consider that much can be done to familiarize people with the use of alcohol as a fuel by exhibiting alcohol engines at work at agricultural shows and other exhibitions in Australia, and they propose either to purchase or to have constructed an engine or engines for demonstration purposes. In this connection the Secretary of the Alcohol Motor Fuel Committee of the Imperial Motor Transport Council, who are co-operating with the Australian Committee, will be glad to receive at 39 St. James Street, London, S. W. 1., any available information as to the cost of efficient alcohol engines and the probable date of delivery. A small stationary engine of 5 to 10 hp. would be preferred, but if it is impossible to obtain delivery of a suitable engine at a comparatively early date a complete set of plans might be purchased with a view to the engine being constructed in Australia.

PRODUCTION

In the opinion of the Committee the supply of alcohol is likely to prove a much more difficult problem than the design of engines for its use. The most economical source for its production at present is said to be molasses, but even if the whole available supply of molasses in Australia were used for the purpose it would be sufficient for the supply of only about 4,000,000 gallons per annum, whereas the annual imports of petrol

are in the neighborhood of 17,000,000 gallons. The average quantity of molasses available annually in Australia for distillation is about 50,000 tons, of which about 12,500 tons are now used for that purpose. The remainder is largely wasted. The present price of alcohol produced from molasses is about 1s. 9d. a gallon, ex store in Melbourne. It appears unlikely that any considerable quantity can be made in Australia from either raw or waste materials not at present utilized. The most important of these materials are waste timber, grass-tree, prickly pear, waste fruit, and straw. The prospects of producing alcohol from cellulose, such as waste timber or straw, on a profitable basis do not seem encouraging. Failing the utilization of raw or waste materials it will be necessary to grow special materials for the purpose. Of these the Committee regard maize, wheat, barley, potatoes, and beet as the most promising, though they are not yet able to give particulars of the cost of manufacture from these sources.

Mr. Rowe thinks that in South Australia potatoes offer the best prospects, but he points out that the crop in the best years, about 33,000 tons, even if all converted into alcohol, would yield only 760,000 gallons, or less than half the present consumption of motor spirit in the State.

DENATURATION

The Committee states that the denaturants at present required for industrial methylated spirits (2 per cent. of wood naphtha and ½ per cent each of pyridine and mineral benzine) cost 1.74d. per gallon of alcohol, and they regard an alteration in the regulations as desirable if alcohol is to be available at as low a price as possible. Their suggestion that 1 per cent of pyridine only, which would reduce the price of denaturants to 0.9d. per gallon of alcohol, would suffice has not been approved of by the excise authorities. They are collecting data with the object of finding a cheap and efficient denaturant which can be produced in Australia, and they express the hope that the authorities will deal with the whole question in a liberal spirit, since otherwise artificial restrictions in the way of the extended use of industrial alcohol will be greatly increased.

Mr. Rowe also insists that the first step towards the production of alcohol on a large scale is a revision of the excise regulations, so as to provide a system of methylation better adapted to a motor spirit than that now in use. He suggests that benzol or petrol, or both, should be allowed for methylation purposes, and that the redistilled condensate from Pintsch gas manufacture would make a cheap and effective denaturant. This liquid contains a large proportion of benzol, and like it will mix with alcohol in all proportions. It would, he says, certainly fill the bill as far as nauseousness is concerned, and it is a powerful fuel as well.

Personal

Mr. **L. Drew Betz,** formerly chemist with the Animal Oil Company, has been appointed chemical director of the Philadelphia plant of E. F. Drew & Company, Delaware Avenue and McKean Street, Philadelphia, Pa.

Mr. **W. R. Gilard** has resigned from the research staff of the Pittsburgh Plate Glass Co. to become Director of Research for The Lancaster Lens Co.

Mr. **Bancroft Gore,** formerly professor of metallurgy in the School of Mines at Butte, has gone to the Naltagua Smelter at El Monte, Chile.

Mr. **L. O. Howard,** consulting engineer of Salt Lake City, has been appointed Dean of the School of Mines of the State College of Washington at Pullman.

Mr. **G. W. Laurie** of the firm of Drucker & Laurie, 50 Church Street, New York City, has joined the Twenty-third U. S. Engineers.

Mr. **Joseph McKay, Jr.,** for thirteen years with the Wheeler Condenser & Engineering Co. and for the past two years with the Pittsburgh Valve Foundry & Construction Co., has recently been engaged as general sales manager of the Deschanel Engineering Corporation, 90 West Street, New York City.

Mr. **F. G. Moses** has been appointed hydrometallurgist in the U. S. Bureau of Mines, with headquarters at Salt Lake City station.

Mr. **Edwin C. Pierce** of Youngstown, Ohio, has been named consulting chemist for the Republic Motor Truck Co. of Alma, Mich., and has equipped a complete chemical and metallurgical laboratory in that city to handle this and other Michigan work. The laboratory is in charge of Mr. Clyde S. Morgan.

Mr. **H. DeWitt Smith** has resigned his position as assistant manager for the Kennecott Copper Corp. and has accepted a position as superintendent of the Mining Department of the United Verde Copper Company at Jerome, Ariz.

Mr. **A. Gordon Spencer,** formerly chief chemist of the Canadian Inspection & Testing Laboratories of Montreal, has severed his connection with that company and is opening an office at 617-8 Transportation Building, Montreal, as a consulting chemist and metallurgist.

Mr. **H. B. Underwood** has severed his connection with the Buffalo Foundry & Machine Company and has identified himself with the Hewitt Rubber Company, Buffalo, N. Y.

Mr. **W. C. Webster,** who has been secretary and General Manager and Director of the Nichols Copper Company, 25 Broad Street, New York, for several years past, has resigned and withdrawn from the company. Mr. Webster expects to take a rest before assuming further duties.

Book Review

Mineral Industry for 1916. By G. A. Roush, A.B., M.S. 939 pages. Price, $10.00. New York: McGraw-Hill Book Co.

The first volume of the Mineral Industry was published by Richard P. Rothwell in 1893. The present volume, therefore, marks the twenty-fifth anniversary of this work, and during this period the editors have given the public annually complete reviews of the mineral industry, not only of the United States but of the world. The present volume is fully up to the high standard which has been set in the past, and in certain respects is even more complete. The editor is to be congratulated in keeping the size of the volume down to reasonable limits, in spite of the temptation to increase in proportion to the growing importance of the subject. This result is accomplished by reducing the space which has frequently in the past been devoted to papers at the end of the work.

The chapter entitled Mineral Industry, on page 1, by Mr. Roush, introduces a new feature. In this chapter, under the head of General Progress, he gives a number of tables presenting in diagrammatic form the production of the various metallic and non-metallic substances. In each case the world's production and the production of the most important countries is shown. All these diagrams, except in the case of tungsten, cover the periods from 1893 to 1916.

The chapters on Abrasives, Aluminium, Antimony, Arsenic, Asbestos, Asphalt, Barium and Strontium, Bismuth, Borax, Bromine and Iodine, Cadmium, Cement, and Chromium give the production of these various products in the usual manner, also consumption, uses, and, in certain cases, bibliographies.

Coal and Coke are treated extensively, and complete information is given in regard to price, production in this country, and, as far as possible, in foreign countries.

The chapter on Copper is most complete, as it should naturally be, in view of the enormous amount of copper furnished by the U. S. in comparison with the world's production. In 1916 this country furnished 62 per cent of the world's output, compared with 60 per cent in 1915 and 56.4 per cent in 1914. Production in this country in 1916 increased 36 per cent in comparison with that of the previous year. This chapter covers 114 pages, and gives complete statistics of the copper trade, the production of copper in this country, and, as far as possible, abroad, and also includes a very thorough review of the Metallurgy of Copper in 1916.

Then follow short chapters on Cryolite, Feldspar, Fluorspar, Fuller's Earth, Graphite and Gypsum, etc.

Gold and Silver, Iron and Steel, Lead, Petroleum, Platinum, Tin and Zinc are dealt with in detail and full information is given about these metals.

The chapter on Precious Stones is quite elaborate, and covers 30 pages.

The only special chapter is one on Ore Dressing and Coal Washing, in which this subject is very ably discussed.

Last, but not least, is a very full and carefully compiled index, which enables one to find with ease the data desired on any particular subject.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Wednesday, Nov. 21.—There is no change in copper and lead. Tin has advanced sharply and spelter has also had a slight advance.

Copper.—There is nothing new in the copper situation and the price remains at 23½ cents as fixed by the government. There seems to be plenty of copper for all needs, but the small consumer is not receiving much and cannot buy much owing to the one price. An investigation of this situation should be made.

Tin.—Tin has advanced sharply. It rose from 72 to 74½ cents from Nov. 8 to 14 and has since jumped to 80 cents for Straits and 72½ for Banka. Arrivals up to Nov. 20 were only 1185 tons with 4100 tons afloat. Probably higher prices than the above mentioned have been paid for small lots.

Lead.—The trust price of lead continues at 6.25 cents New York. Sales have also been made for January, February and March at this figure. Independents have asked 6.50 cents. A good business has been done in lead for some time.

Spelter.—The spelter market has been quiet, although the price has advanced from 7½ to 8 cents over a period of about a week. The producers organized a committee Nov. 13 to co-operate with the War Industries Board in fixing prices. Members of the new committee are Edgar Palmer, chairman, C. T. Orr, Cornelius F. Kelly, C. M. Loeb, Sidney J. Jennings, N. Bruce McKelvie, Charles F. Baker, Walker W. Vick, R. A. Cowles, A. P. Cobb, E. W. Furst, S. M. Evans, J. D. Lang and S. S. Tuthill.

OTHER METALS

Aluminium, lb	.36	.38
Antimony, lb	13½	.14
Bismuth, lb		3.50
Cadmium, lb		1.50
Nickel, electrolytic, lb		.55
Quicksilver, flask		100.00
Silver, oz		.86
Platinum		105.00
Palladium, oz	115.00	120.00

The Iron and Steel Market

Since the announcement of the War Industries Board's third batch of iron and steel prices on Nov. 5, noted in last issue, the general regulation of prices and trade practices in the iron and steel industry has passed, in substance, to the American Iron and Steel Institute, which, after careful work by various committees, has made a number of lengthy announcements as to extras and differentials applying to the basis commodities upon which the War Industries Board set prices, and as to prices for commodities related to the fundamental products for which prices were set. These other commodities are chiefly manufactures of iron and steel. Thus the announcement of skelp prices as well as a basis price for standard steel pipe by the War Industries Board has been followed by the announcement of boiler-tube prices by the institute. Rod prices have been followed by chain prices, bar and rod prices by prices for rivets, bolts and nuts, etc., prices for common sheets by prices for electrical sheets, and so along the line.

Control Working Smoothly

The first thing to be said about this altogether sweeping change in methods of conducting the iron and steel business is that the control is working smoothly, much more smoothly than the great majority had anticipated. Buyers and sellers know precisely what the prices are, so far as the work of setting prices and establishing relations has gone, and in that respect they are much better off. Sellers are clearer in their mind as to what they should sell and what they should not sell, while buyers are clearer in mind as to what they should buy and what they should not buy.

In general, it is possible to buy at the set prices, and for relatively early deliveries, much earlier deliveries in most cases than had been expected. Buyers were afraid that there would not be nearly enough steel, and that they would be left in an embarassing position when they were denied the right of competitive bidding, a right which, as a matter of fact, they had been exercising to their own detriment. Some of them also feared that producers would simply step out of the market and refuse to sell, as in substance their agreement with the Government was not that they would sell to the public

at certain prices but that in case they did sell it would not be at above those certain prices.

These fears have not been realized. The great majority of producers are quite ready to sell to regular customers who can show that they really need material. There would be a still broader sales policy were there not the danger of some consumers seeking to buy at the set prices when they were under contract to take material previously bought at higher prices. It is safe to assert that the great majority of producers are striving earnestly to carry out the full spirit of the price-control arrangement as well as the mere letter.

Pig-Iron Contracts

The blast-furnace men, as a class, have shown a strong desire to "play the game" to the full. Not only do they strain a point to make a sale and guarantee prompt delivery in the case of a customer needing iron, but they stand ready to make contracts for part or all of next year's delivery, under contracts not merely at the set price, but with a proviso that the price is guaranteed against Government change in price as to any unshipped tonnage at the time of the price change. As no one expects that the pig-iron prices will be revised upward, this provision is altogether in favor of the buyer. A very considerable volume of business has thus been put through. The price limit on No. 2 foundry and basic iron, f.o.b. furnace, is $33.

Commercial Requirements Were Decreasing

While it is extremely creditable to iron and steel producers that they have adopted, with such breadth of action and willingness of spirit, the price control, there is no occasion to ignore the fact that the commercial consumption of steel had begun to decrease, and is bound to decrease still more. In many directions, commercial activities involving the consumption of iron and steel are decreasing, and market prospects, from either the price or the tonnage standpoint, are not as good as they were a few months ago, when many were asserting that price control for the entire trade was undesirable, if not impractical.

If it were possible for the steel industry to convert its tonnage of ingots into finished products in any proportions desired, it is altogether improbable that the ingot supply would be sufficient to meet all demands; but on account of the specialization of the rolling departments this cannot be done, and thus it is hardly improbable that steel in all forms will be distinctly scarce. Rather it will be scarce in certain forms only.

Production Difficulties

It has become doubtful whether iron and steel production can be maintained indefinitely during the war at the rate obtaining in the past few months, even though that rate is in the neighborhood of 10 per cent below rated capacities. During the past fortnight the traffic situation has become much worse, particularly with respect to the movement of coke, and pig-iron production is restricted in consequence. The railroads are breaking down under the load, and yet winter weather is at hand, and that always adds to the difficulties.

The Washington authorities are making strenuous efforts to encourage the production of iron and steel, but with indifferent success. Partly to relieve the railroads, and partly to increase the supply of labor for essential war work, there is to be more or less restriction of certain industrial activities. What are to be called "unessentials," in other words, are to be marked for curtailment. The plans are in embryo as yet. One mode of procedure is to debar certain materials from railroad transport, the other being to deal directly with specific industries whereby their activities may be curtailed, and the relative extent to which each method may be prosecuted is not yet clear. The curtailment in the unessentials will affect in certain respects the consumption of iron and steel, but no forecast can be made at this time as to the iron and steel tonnage that may be involved.

Government orders for steel are increasing, and promise to involve a larger tonnage than was expected even a few weeks ago. The shell-steel requirements will be particularly large. This matter is to be judged not by the tonnage of orders being placed but by the activity in seeking manufacturers who will accept orders for shells. Orders are being placed in Canada, and as to the United States the Government is not satisfied with resurrecting the shell factories that in the past were so active in making shells for our present Allies, but is seeking information as to other plants that can be converted for shell manufacture. The total shell-steel tonnage required of the mills, therefore, is likely to be greater than they have produced at any time in the past.

Practically the entire iron and steel market is now under price control, and a few basis prices are quoted: Billets, $47.50; small billets, $51; slabs, $50; sheet bars, $51; rods, $57; bars, 2.90c.; shapes, 3c.; plates, 3.25c.; blue annealed sheets, 10 gage, 4.25c.; black, 28 gage, 5c.; galvanized, 28 gage, 6.25c.; standard steel pipe, 51 per cent off list as basis; plain wire, 3.25c.; wire nails, $3.50; tin plate, $7.75.

Chemical Market

Benzol.—The position is very unsteady, in fact it is weakening day by day. Offerings are freely made and buyers on contract over 1918 are being made inducements, with a possibility of bettering same in the course of a few weeks.

Phenol.—While the position is not as firm, as previously, offerings continue restricted, but the demand is not great and it is predicted that a lower level will prevail shortly.

Toluol.—Governmental authorities have requisitioned all lots of consequence and while manufacturers of necessities are receiving such supplies as will tide them over short terms, there is practically none on the market.

Naphthalene.—The position is fairly well maintained; although it is not as strong as heretofore, offerings are made in only a limited way, with fair consuming interest.

Benzoate of Soda.—The toluol situation has brought about a strong position in this product. Practically all factors are sold up for a month or more and advances have been scored in both the acid and the soda, with probabilities of further advances generally admitted. There is a goodly demand with stocks at a low ebb.

Aniline Oil.—No great demand is prevalent and

offerings are liberally made at an attractive figure, with the position weak.

Beta Naphthol.—The position is unchanged. There is a fair demand with prices holding fairly firm, but there is a plenitude of stock on hand.

Heavy Chemicals.—There has been a noticeable slump in trading in heavy chemicals during the past two weeks. The approach of the year end, together with the unfavorable stock market and slowness of collections, has created a halting tendency. As is usual toward December the question of contracts for the new year is always to the front and this naturally restricts trading in spot and nearby positions. There has been generally a pronounced weakness in most products under this classification.

Caustic Soda.—The speculative element has not been quite so pronounced during the past two weeks, and while the market has held at about the level last reported, it has not been firm by any means. The scarcity of real offers of spot and nearby material has added strength to the market which would not have been apparent otherwise. The product is still under the control of dealers, the works having practically nothing to offer to an ordinary buyer. There has been some business placed over 1918 at the relatively high price of 6.65 for deliveries of several cars monthly over the year.

Soda Ash.—The spot position has not been very firm, but for shipment from the works there has been a lack of genuine offers, and this position has generally been difficult to obtain. Barrels have been scarce and have as a rule commanded a premium over bags out of the usual proportion. Dense ash has been extremely difficult to secure and the country is being scoured for supplies.

Formaldehyde.—In contrast to the general chemical situation the market for this product has been active and has been subject to a sharp advance during the interval, with stocks now reduced to a minimum. Deliveries over next year are restricted, with manufacturers offering to regular consumers only.

Bichromate of Soda.—Under pressure of low prices offered for next year deliveries the spot material has receded, with the natural result that trading has been much restricted and transactions reduced to a minimum. Deliveries over 1918 have been named at 16½ to 17c.

Cyanides.—There have been cheap offerings reported from various out-of-town points. Chicago reported lots of R&H material available there at 45c. Locally, 48 to 52c. was quoted, but the material has not been moving freely into consumption.

Prussiates.—Spot lots of soda have been sold at price concessions, but round lots have held well and the inquiry has been fairly good. Potash on the other hand has been in very good request and there has been considerable quiet buying with prices held firm, although an occasional lot has appeared here or there at some five points or so under the market.

Mineral Acids.—The sulphuric acid situation has been quiet, but it has been very firm and offerings have been much restricted. Probably a half million tons of acid could be sold for a quick delivery to-day if it were available at a price. Both brimstone and pyrites continue scarce and producers and shippers are taking no new business. The cost of landing Spanish sulphur ore at Atlantic coast points is now so high that there is practically no difference between brimstone and pyrites acid prices. Nitric acid rules firm, although nitrate of soda is again much lower. Sulphuric acid and packages are high and the cost of acid laid down at consuming points is close to the 10c. level, even for large quantities. Muriatic acid has been slow in comparison with other acids, but the situation is firm.

Nitrate of Soda.—Resale lots have influenced values to a marked degree and there has been a drop from the high level of 5.10 to the present level of 4.50, at which a large tonnage has been offered the past few days. The production in Chile has been large and the importations into this country have apparently been in excess of the normal consumption.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 22, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.36 —	.37
Acid, acetic, 28 per cent	lb.	.05¾ —	.06
Acetic, 56 per cent	lb.	.11 —	.12
Acetic, glacial, 99½ per cent, carboys	lb.	.40 —	.50
Boric, crystals	lb.	.14 —	.14¼
Citric, crystals	lb.	.70 —	.71
Hydrochloric, C.P	lb.	.08¼ —	.08¾
Hydrochloric, 20 deg	lb.	.02⅛ —	.02⅛
Hydrochloric, C.P., conc., 22 deg	lb.	.02¼ —	.02⅜
Hydrofluoric, 30 per cent, in barrels	lb.	.06¼ —	.06⅛
Lactic, 44 per cent	lb.	.15½ —	.16½
Lactic, 22 per cent	lb.	.06¼ —	.07¼
Nitric, 36 deg	lb.	.07¼ —	.07⅜
Nitric, 42 deg	lb.	.09¼ —	.10
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 47 per cent-50 per cent	lb.	.07½ —	.
Picric	lb.	.75 —	.85
Pyrogallic, resublimed	lb.	3.15 —	3.25
Sulphuric, 60 deg	ton	25.00 —	30.00
Sulphuric, 66 deg	ton	36.00 —	40.00
Sulphuric, oleum (Fuming), tank cars	ton	55.00 —	60.00
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.79 —	.82
Tungstic, per lb. of W	lb.	1.80 —	1.90
Alcohol, superfine, 188 proof	gal.	5.20 —	5.40
Alcohol, wood, 95 per cent	gal.	1.20 —	1.22
Alcohol, denatured, 180 proof	gal.	.84 —	.86
Alum, ammonia lump	lb.	.04½ —	.05
Alum, chrome ammonium	lb.	.20 —	.21
Alum, chrome potassium	lb.	.26 —	.27
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08¾ —	.09
Aluminium sulphate, technical	lb.	.02½ —	.03¼
Aluminium sulphate, iron free	lb.	.03½ —	.04
Ammonia aqua, 26 deg. carboys	lb.	.17 —	.18
Ammonium carbonate	lb.	.11½ —	.12½
Ammonium nitrate	lb.	.18 —	.20
Ammonium, sulphate domestic	lb.	.07½ —	7.15
Amyl acetate	gal.	5.25 —	5.40
Arsenic, white	lb.	.16 —	.16½
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	70.00 —	.....
Barium carbonate 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	70.00 —	80.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½ —	.05
Barium nitrate	lb.	.08½ —	.11½
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼ —	.01½
Borax, crystals, sacks	lb.	.07½ —	.07¾
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.65 —	.70
Calcium, acetate, crude	lb.	.06 —	.06⅛
Calcium, carbide	lb.	.08½ —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	... —	.....
Carbon bisulphide	lb.	.07 —	.07½
Carbon tetrachloride, drums	lb.	.16 —	.16½
Caustic potash, 88-92 per cent	lb.	.84 —	.84½
Caustic soda, 76 per cent	lb.	.07⅞ —	.09
Chlorine, liquid	lb.	.15 —	.18
Cobalt oxide	lb.	1.40 —	1.50
Copperas	lb.	.01¼ —	.01½
Copper carbonate	lb.	.45 —	
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.0965—	.0975
Cream of tartar, crystals	lb.	.55 —	.57
Epsom salt, bags	lb.	.03¼ —	.04
Formaldehyde, 40 per cent	lb.	.18 —	.19
Glauber's salt	100 lb.	1.20 —	1.35
Glycerine, bulk, C. P	lb.	.70 —	.71
Iodine, resublimed	lb.	4.25 —	4.35
Iron oxide	lb	.13 —	.15
Lead, acetate, white crystals	lb.	.17½ —	.19
Lead arsenate	lb.	.16 —	.20
Lead nitrate	lb.	.17½ —	.18
Litharge, American	lb.	.09½ —	.11½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.48 —	.55
Magnesium carbonate, tech	lb.	.10 —	.11
Nickel salt, single	lb.	.14½ —	.....
Nickel salt, double	lb.	.11½ —	.....
Phosphorus, red	lb.	1.70 —	.....
Phosphorus, yellow	lb.	2.10 —	2.15

Potassium bichromate	lb.	.45	-	46
Potassium bromide granular	lb.	1.35	—	1 40
Potassium carbonate calcined, 85-90 per cent	lb.	.75	—	.
Potassium chlorate, crystals	lb.	.46	—	.48
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	2 90	—	3 00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	350.00	—	375 00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4 00
Potassium prussiate, red	lb.	3.00	—	.
Potassium prussiate, yellow	lb.	1 27	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	400 00	—	.
Rochelle salts	lb.	.39	-	.39½
Salammoniac, gray gran.	lb.	.11½	-	.12½
Salammoniac, white gran.	lb.	.16	-	.18
Sal soda	100 lb.	1 15	—	1 25
Salt cake	100 lb.	1 50	—	2 00
Silver cyanide, based on market price of silver	oz.	.		.
Silver nitrate	oz.	.57		.59
Soda ash, 58 per cent. light, flat	100 lb.	3 05	-	3 10
Soda ash, 58 per cent, dense, flat	100 lb.	4 00	-	.
Sodium acetate	lb.	.14	-	.15
Sodium benzoate	lb.	3 00	—	.
Sodium bicarbonate, domestic	lb.	.02⅝	-	.03
Sodium bicarbonate, English	lb.	.	—	.
Sodium bichromate	lb.	.18½	—	.20
Sodium bisulphite, powd.	lb.	.06¼	—	.06½
Sodium chlorate	lb.	.23	-	.25
Sodium cyanide	lb.	.48	-	.51
Sodium fluoride, commercial	lb.	.18½	-	.
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4 65	—	4 75
Sodium nitrite	lb.	.33	—	.35
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate	lb.	.04	—	.04½
Sodium prussiate, yellow	lb.	.35	—	.37
Sodium silicate, liquid	100 lb.	1 80	—	2 00
Sodium sulphide, 30 per cent crystals	lb.	.02½	—	.03½
Sodium sulphide, 60 per cent, fused	lb.	.04	-	.04½
Sodium sulphite	lb.	.04	-	.05⅛
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4 05	-	4 10
Sulphur, roll	100 lb.	3.70	-	3 85
Sulphur, crude	ton	60.00	—	65 00
Tin bichloride, 50 deg.	lb.	.21	—	.22
Tin oxide	lb.	.72	—	.75
Zinc carbonate	lb.	.35	—	.38
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	.
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.16	—	.17
Zinc sulphate	lb.	.05½	—	.05¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.40	-	.42
Benz l, 90 per cent	gal.	.45	-	.47
Toluol, pure water white	gal.	Nominal		
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	-	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P.	lb.	.19		.20

Intermediates, Etc.

Apha naphthol, crude	lb.	1 10	—	.
Alpha naphthol, distilled	lb.	1.60	—	.
Alpha naphthylamin	lb.	.60	—	.65
Aniline oil, drums extra	lb.	.25¾	—	.26
Aniline salts	lb.	.31½	—	.33
Anthracene, 80 per cent	lb.	.10	—	.
Benzaldehyde	lb.	4 00	—	4.50
Benzidine, base	lb.	1.80	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	2.50	—	2.75
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.00	—	8.00
Beta naphthol, sublimed	lb.	.85	—	.87
Beta naphthylamin com.	lb.	2.50	—	2 65
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3.75	—	4 25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.42	—	.44
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.62
Dimethylaniline	lb.	.60	—	.65
Diphenylamine	lb.	1.00	—	.
H-acid	lb.	3.00	—	3 50
Metaphenylenediamine	lb.	1.75	—	1 80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09¾	—	.10
Naphthalene, balls	lb.	.10½	-	.10¾
Naphthionic acid, crude	lb.	1 50	—	1 75
Naphthylamin-di-sulfonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	.		.
Ortho-toluidine	lb.	.90	—	1.00
Orth-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	4.50	—	5.00
Para-amido-phenol, H. Ch.	lb.	5.25	—	5.75
Paranitraniline	lb.	1.10	—	.
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.25	—	.
Phenol, U. S. P.	lb.	.52	—	.53
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.00	—	13.50
Salicylic acid	lb.	1.35	—	1.38
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	2.50	—	.
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	.
Corning, Ohio	bbl.	2.60	—	.
Somerset, Ky	bbl.	2.40	—	.
Wooster, Ohio	bbl.	2.38	—	.
Indiana	bbl.	1.98	—	.
Illinois	bbl.	2.12	—	.
Oklahoma and Kansas	bbl.	2.00	—	.
Caddo, La., light	bbl.	2.00	—	.
Corsicana, Tex., light	bbl.	2.00	—	.
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	.

Fuel Oil

New York	gal.	.10½	—	.
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans.	bbl.	.70	—	1.55
Texas	bbl.	1.60	—	.
Los Angeles	bbl.	1.45	—	.
San Francisco	bbl.	1.45	—	.

Gasoline (Wholesale)

New York	gal.	.24	—	.
Boston	gal.	.25	—	.
Pittsburgh	gal.	.26	—	.
Chicago	gal.	.21	—	.
Oklahoma	gal.	.23	—	.
San Francisco	gal.	.20	—	.

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13½	—	.14
Cylinder, light	gal.	21	—	.26
Cylinder, dark	gal.	18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	18½	—	19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	.
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—	.
Pine oil, destructively distilled	gal.	43	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—	.
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	.
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	-	.
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	-	.
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.32	—	.
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	.
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—	.
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—	.
Wood creosote, ref. f.o.b. Florida	gal.	.30½	—	.

Vegetable and Other Oils

China wood oil	lb.	.22		.23
Cottonseed oil, crude	gal.	1.30	—	.
Linseed oil, raw, cars	gal.	1.18	-	1.20
Peanut oil, crude	gal.	1.38	—	.
Rosin oil, first run	gal.	.35	—	.
Rosin oil, fourth run	gal.	.66	—	.
Soya bean oil, Manchuria	lb.	.16½	—	.17
Turpentine, spirits	gal.	.51	-	.

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Carnauba wax, flor	lb.	.62	—	.
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.	—	.
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb.	bbl.	6.95	—	.
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40 00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent. carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	.
Ferrochromium, per lb. of Cr	lb.	.35	—	.40
Ferromanganese, domestic	ton	250.00	—	.
Ferromanganese, English	ton	325.00	—	.
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y.	ton	.	—	.
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	250.00	—	.
Ferrosilicon, 50 per cent, contract	ton	100.00	—	175 00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	.
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Antimony ore, per unit		1 60	-	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.20
Manganese ore, chemical	ton			$100.00
Molybdenite, per lb. of MoS_2	lb.	.2 15	—	2.25
Tungsten, Scheelite, per unit of WO_3	ton	26.00	—	27 50
Tungsten, Wolframite, per unit of WO_3	ton	25.00	—	26.00
Uranium oxide, 96%	lb.	3 25	-	3.60
Vanadium Pentoxide, 99%	lb.			10.50
Pyrites, foreign	unit	.16	—	.16¼
Pyrites, domestic	unit	20	—	.

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The American Steel Products Corporation, New York. Capital, $1,000,000. To manufacture iron and steel specialties. Incorporators: W. S. Brewster, W. P. Kellett and W. B. J. De Lacey, 233 Broadway.

The American Zinc Products Company, Warren, Ohio. Capital, $1,000,000. To manufacture zinc sheets and allied products, with proposed plant to be located at Greencastle, Ind. Incorporators: D. W. Kerr, F. W. Stillwagon, W. Manning Kerr and G. P. Gilmer.

The Automotive Industrial Corporation, New York. Capital, $10,000. To manufacture motor devices. Incorporators: C. Bloom and S. E. Stone, 33 Lincoln Arcade Building.

The Bario Metal Corporation, New York. Capital, $90,000. To manufacture electric furnaces. Incorporators: P. Demiles, N. Herbschleb and H. Jenkins, 31 Park Row.

The Birch Paper Corporation, New York. Capital, $100,000. To manufacture paper goods. Incorporators: G. P. Breckenridge, J. E. Lauber and B. Becerra, 11 Wall Street.

The Black Hawk Lead & Zinc Company, Miami, Okla. Capital, $250,000. To operate lead and zinc properties. Incorporators: G. N. Williams and U. S. G. Evans, Miami, and J. P. Gilmore, Tulsa.

The Columbia Tire & Rubber Company, Wilmington, Del. Capital, $1,500,000. To manufacture automobile tires and other rubber goods. Incorporators: A. M. Halloran, S. A. Williams and Ferris Giles, Wilmington.

The Community Chemical Company, Dover, Del. Nominal capital, $5,000. To manufacture chemicals. Incorporators: L. B. Phillips and J. B. Bailey, Dover.

The Compound Specialty Company, New York. Capital, $50,000. To manufacture chemicals and chemical compounds. Incorporators: S. Baer, 1286 Lexington Avenue; M. L. Schaller, 176 West Eighty-seventh Street, and J. R. Roth, 180 St. Nicholas Avenue, New York.

The Connecticut Brass Foundry Company, Waterbury, Conn. Capital, $10,000. To operate brass and bronze foundries. The company has recently acquired the Pilling Brass Company, Waterbury, and will operate the plant.

The Delaney Forge & Iron Company, Buffalo, N. Y. Capital, $750,000. To manufacture iron and steel products. Incorporators: J. L. Emerson, J. A. Hall and J. T. Dillon, Buffalo.

The DeVoe-Smith Company, Newark, N. J. Capital, $50,000. To manufacture automobiles. Incorporators: Alonzo DeVoe and Prescott S. Smith, Newark, and Lester A. DeVoe, Ridgewood, N. J.

The Electrosynth Chemical Company, New York. Nominal capital, $5,000. To manufacture chemicals. Incorporators: J. M. Winston, H. and M. Abrams, 130 West 113th Street.

The Endurance Tire & Rubber Company, Wilmington, Del. Capital, $5,000. To manufacture automobile tires. Incorporators: C. L. Rimlinger and F. A. Armstrong, Wilmington, and Clement M. Egner, Elkton, Md.

The Eureka Metallurgical Company, Salt Lake City, Utah. Capital, $50,000. To manufacture experimental apparatus for the separation of lead and zinc carbonates, etc. Incorporators: M. A. McChrystal, Reinold V. Smith, Edward Pike and Thomas McCormick.

The Fidelity Tire & Rubber Company, Jersey City, N. J. Capital, $5,000. To manufacture automobile tires and rubber specialties. Incorporators: Richard Kramer, Clason Point, L. I.; James L. Meltzer, New York, and F. O. Sheehan, New York.

The Fore Chemical Works, Jersey City, N. J. Capital, $497,000. To manufacture chemicals. Incorporators: M. W. Alexander, R. E. Breed and U. M. Fleischman, Wilmington, Del.

The Gibson-Clarke Company, Indiana, Pa. Nominal capital, $5,000. To manufacture farm machinery and other apparatus. Principal incorporator: Lewis G. Clark, Indiana.

N. Z. Graves, Inc., Philadelphia, Pa. Nominal capital, $5,000. To manufacture paints and oils. Principal incorporator: Nelson Z. Graves, Philadelphia.

The Great Northern Oil & Refining Company, Oklahoma City, Okla. Capital, $100,000. To construct and operate an oil refining works. Incorporators: J. E. Ireson, W. M. Null and S. K. Bernstein, Oklahoma City.

The Grove City Brass and Bronze Company, Grove City, Pa. Capital, $25,000. To manufacture brass and bronze products. Principal incorporator: T. A. Sampson, Mercer, Pa.

The Gun Corporation, New York. Capital, $25,000. To manufacture machine guns. Incorporators: E. J. Nathan, Jr., B. Howie and M. L. Macauley, 128 Broadway.

The Hanover Lead & Zinc Company, Miami, Okla. Capital, $160,000. To operate lead and zinc properties. Incorporators: J. J. Strong, C. W. Rice and Rudolph Johnson, Cushing, Okla., and J. T. Dickinson, Edmond, Okla.

The Healdton Lead & Zinc Company, Oklahoma City, Okla. Capital, $100,000. To operate a zinc and lead works. Incorporators: William A. Rodgers, John Mulkey and H. S. Cox, Ardmore, Okla.

The Hendee Wrench Manufacturing Company, Wilmington, Del. Capital, $200,000. To manufacture wrenches and tools. Incorporators: S. A. Williams and A. M. Halloran, Wilmington.

The Indian Tool Company, Pittsburgh, Pa. Capital, $35,000. To manufacture tools. Principal incorporator: August Weinman, Pittsburgh.

The Ingalls Iron Works, Birmingham, Ala. Capital, $250,000. To operate a local foundry for the manufacture of iron and steel specialties. Incorporators: R. I. Ingalls, R. D. Leach, A. L. Gilliland and E. G. Ingalls, Birmingham.

The J. O. Jensen Company, Geneva, N. Y. Capital, $50,000. To manufacture glass products. Incorporators: J. O. and C. A. Jensen and J. Henle, Geneva.

The King Glass Company, Kokomo, Ind. Capital, $100,000. To manufacture glass specialties of various kinds. Incorporators: E. B. King, C. D. Wells and William M. Wells.

The Lawrence Implement Company, Roanoke, Va. Capital, $30,000. To manufacture agricultural implements of various kinds. Incorporators: J. S. and J. G. Lawrence, Roanoke.

The Liberty Phonograph Company, Brooklyn, N. Y. Capital, $1,500,000, with Delaware charter. To manufacture talking machines. Incorporators: Alfred A. Case, Brooklyn, and Dudley E. Case, Jersey City, N. J.

The Limited Steel Products Company, New York. Capital, $60,000. To manufacture steel and iron specialties. Incorporators: S. P. Durenheimer, O. C. Deutscher and F. C. Canfield, 341 Fifth Avenue.

The Little Giant Truck Company, Wilmington, Del. Capital, $50,000. To manufacture automobile trucks. Incorporators: M. M. Clancy, Wilmington and Clement M. Egner, Elkton, Md.

The Make-a-Tractor Corporation of America, Wilmington, Del. Capital, $1,500,000. To manufacture motor-driven tractors. Principal incorporator: C. L Rimlinger, Wilmington.

The Markleed Chemicals Corporation, New York. Capital, $220,000. To manufacture chemicals and paints. Incorporators: L. H. Marks, New York; H. C. Aron, 55 West Tenth Street, New York, and H. M. Wise, Woodcliff, N. J.

The Marren Manufacturing Company, Wilmington, Del. Capital, $500,000. To manufacture machinery and motors. Principal incorporator: F. A. Armstrong, Wilmington.

The Mexokakan Oil & Refining Company, Tulsa, Okla. Capital, $850,000. To construct and operate an oil refining plant. Incorportors: S. L. Hess, Alva, Okla.; G. T. Nickles and W. H. Sandy, Tulsa.

The Miner-Edgar Company, Newark, N. J. Capital, $100,000. To manufacture chemicals. Incorporators: Henry M. Miner, James C. Thornton and N. M. Goodlet, Jr., all of Newark.

The Misener & Irving Manufacturing Company, Syracuse, N. Y. Capital, $50,000. To manufacture tools, etc. Incorporators: J. I. Misener, A. Pearsall and E. V. B. Tyminski, all of Syracuse.

The Moreton Accessories Company, Wilmington, Del. Capital, $100,000. To manufacture spark plugs and other automobile accessories. Local incorporator: C. L. Rimlinger.

The Provident Manufacturing & Chemical Company, Los Angeles, Cal. Capital, $10,000. To manufacture chemicals. Incorporators: H. C. Hollins, Frank Hollins and D. W. Coons, all of Los Angeles.

The Republic Bag Company, New York. Capital, $100,000. Incorporators: R. Kest, W. P. Gray and A. Newman, 853 East 176th Street.

Construction and Operation

Alabama

BIRMINGHAM.—The Perfection Mattress & Spring Company is planning to equip a section of its works for the manufacture of wire clothes hangers.

BIRMINGHAM.—The Sloss-Sheffield Steel & Iron Company is making repairs in its No. 3 furnace, and is planning for early operation.

California

LOS ANGELES.—The National Engineering Company, Wilmington, near Los Angeles, has filed plans for the erection of a new one-story machine shop addition to its plant. The structure will be about 45 x 75 ft.

LOS ANGELES.—The Moreland Truck Company, manufacturer of motor trucks, has had plans prepared for the construction of a new one-story addition to its foundry, about 40 x 100 ft., which is to be erected in connection with its new plant at Burbank.

LOS ANGELES.—The Central Machinery Manufacturing Company has had plans prepared for the erection of a new one-story factory building on San Pedro Street. The structure will be about 40 x 125 ft.

LONG BEACH.—The Craig Shipbuilding Company has made application to the City Council of San Diego for permission to construct a new shipbuilding plant near the municipal pier, at a cost of about $500,000.

BRAWLEY.—The City Council is considering the installation of a municipal electric power plant. George R. Wade is city engineer.

SAN DIEGO.—The Savage Arms Corporation has taken over the plant of the Independent Sash & Door Company, Market Street, and is planning for the installation of new machinery to specialize in the manufacture of guns.

VENTURA.—The Ventura Manufacturing Company, specializing in the manufacture of agricultural implements, is planning to increase its output by the erection of a new plant, site for which is now under consideration near Torrance. Upon completion of the new works, the company will remove its entire business to the new location.

SAN LUIS OBISPO.—Ravens, Aleg & Hammer, Los Angeles, have secured the property of the old local whaling station, and are planning for the construction of a plant for the manufacture of potash. The site is located on the north side of San Simeon Bay, and two barges are now at work securing kelp for conversion into potash.

ANTIOCH.—Mason Bros. of Sausalito have secured 90 acres of land, and will erect $500,000 plant for manufacture of potash, acetone, sulphate of ammonia, etc.

Connecticut

NEW BRITAIN.—Bids have been taken by Landers, Frary & Clark, manufacturers of electrical appliances, for the immediate construction of a one-story addition to their plant, about 50 x 325 ft. The structure is estimated to cost about $25,000.

YALESVILLE.—Fire recently destroyed a portion of the two-story factory building of the Connecticut Screen & Cabinet Company. The loss is estimated at about $6,000, and it is said that the destroyed part will be immediately rebuilt. Charles H. Cheeney and Charles A. Runge head the company.

Delaware

NEW CASTLE.—The Bethlehem Steel Company has been awarded a large contract by the Government for projectiles, and it is expected to give employment to about

3000 additional hands at the projectile manufacturing plant of the company, south of the city.

WILMINGTON.—The Pusey & Jones Company has taken bids for the erection of a new one and five-story foundry, pattern works and storage shop at its shipbuilding works, foot of Poplar Street, to cost about $150,000.

WILMINGTON.—The Asbestos Auto Hood & Capsule Container Company, recently incorporated in Detroit, Mich., is planning to purchase a local site of about twelve acres for the construction of a plant to be devoted to the manufacture of automobile hoods and bodies, compressed asbestos and capsule containers for the shipment of high explosives. Property a short distance from the city limits is now under consideration. The new plant will give employment to about 1000 hands. James M. Cutheil, Charles Milligan and Robert T. Beyer, all of Detroit, head the company.

WILMINGTON.—The General Chemical Company has commenced the construction of a block of thirty-nine dwellings for the workmen employed at its plant. The buildings are to be erected along the Philadelphia turnpike at Claymont, and the company is planning for the erection of one hundred and forty houses in all

Florida

JACKSONVILLE.—The Brooks-Scanlon Lumber Company has acquired the saw mill of the Carpenter-O'Brien Lumber Company at Eastport, and is planning to double the capacity. The company will also erect a large new pulp and paper mill to have a capacity of about 100 tons of kraft paper daily.

MORRISTOWN.—The Acme Phosphate Company, Chicago, Ill., is planning for the construction of two new additions to its local plant, about 40 x 200 ft. and 30 x 150 ft. The company, which has heretofore operated the works for the washing of hard phosphate exclusively, will utilize the new buildings for the purpose of preparing and marketing double crop soft phosphate in addition to its hard phosphate output. Machinery for the new plant has been ordered, including dryers, tube mills, conveyors and steam power plant equipment.

PENSACOLA.—The Pensacola Fertilizer & Oil Company has acquired a site on Town Point, across the bay, for the construction of a new plant for the production of fertilizer and oil from menhaden, a small fish found in abundance in Gulf waters, by special process. The machinery for the new plant has been ordered and will be installed immediately upon completion of the works. C. H. Munger is president of the company

Illinois

CHICAGO.—The Apex Electric Manufacturing Company, Fifty-ninth Street, has had plans prepared for the construction of a new one-story addition to its plant. The structure will be about 25 x 50 ft.

CHICAGO.—The Ehman Tire & Rubber Company, 144 West Twenty-seventh Street, has awarded a contract for the erection of its proposed new two-story and basement addition, about 50 x 100 ft. J. L. Carnegie & Son, 189 West Madison Street, Chicago, is the contractor. The structure will cost about $50,000.

CHICAGO.—The Great Western Smelting Company, Forty-first Street, is planning for the construction of a new one-story machine shop, about 100 x 100 ft., at Whiting, Ind.

EAST ST. LOUIS.—The St. Louis Coke & Chemical Company, recently incorporated with a capital of $15,000,000, has had plans prepared for the construction of a large new plant on a site of 250 acres of land now under consideration, and will engage in the manufacture of metallurgical coke from Illinois coal. The blast furnace unit of the works will consist of three furnaces with a capacity of 500 tons each. Smelting of iron ore will be done in conjunction with the carbonizing of coal, and hot metal will be supplied to the steel plants in the vicinity, which will afford a great saving in the consumption of pig iron heretofore brought in from northern and southern districts. The by-product of the coke plant will be gas, tar ammonia products, toluol xyol, benzoin, solvent naphtha, etc. The works, which will give employment to about 1200 hands, will, when completed, represent an investment of approximately $10,000,000

Indiana

GARY.—The United States Steel Corporation has inaugurated operations in its new 160-in. plate mill just completed. Work is being rushed on the new plate mill now in course of construction at South Chicago, and it is expected that the plant will be completed before the close of the year

SOUTH BEND.—The Studebaker Corporation, manufacturer of automobiles, is making rapid progress in the construction of a new local plant, which, when completed, will cost about $2,000,000. The work includes the erection of a new machine shop, four-story dry kiln, a forge shop, and a large power house for plant operation.

Kansas

WICHITA.—The Liberty Pipe Line & Refining Company is planning for the construction of a 3-in. pipe line from the A-1 pool, Wichita, to Douglass. The company is also planning for the erection of a new refinery to handle the product of the A-1 Oil Company in Butler County.

Kentucky

WINCHESTER. — The French - Agnew Torpedo Company, Zanesville, Ohio, is considering the erection of a large local plant for the manufacture of nitroglycerine.

Louisiana

GRETNA.—The American Cotton Oil Company, New Orleans, is planning for the construction of a new local plant to be devoted to the production of glycerine from cottonseed oil.

MONROE.—Alton Brown and associates, Pittsburgh, Pa., have acquired a site of about 700 acres and are planning for the construction of a new plant for the production of carbon, to cost approximately $200,000. The site is on the location of the R. L. Moore tract, a few miles northeast of Monroe.

SHREVEPORT.—The Henderson Cotton Oil Company, recently incorporated with a capital of $400,000, has completed the construction of its new plant, which has a daily capacity of 200 tons of seed. The new works represent an investment of about $150,000.

Maryland

BALTIMORE.—The Standard Oil Company has had plans prepared for the construction of a new five-story addition to its plant at Pratt and Penn Streets, about 38 x 130 ft. Blanke & Zinc, Equitable Building, Baltimore, are the architects.

Massachusetts

ATHOL.—The Athol Manufacturing Company has commenced the construction of two new additions to its plant. The new structures will be two-story, brick, about 40 x 96 ft., and one-story brick, 30 x 120 ft. The company manufactures pneumatic rubber goods, etc

BOSTON.—The Safepack Paper Mills, manufacturers of waterproof paper, have completed the construction of their new plant at Millis, and have removed their entire business to the new location.

LYNN.—The Lynn Rubber Goods Manufacturing Company, manufacturer of rubber heels, soles, etc., has acquired a site in Clifton, R. I., and is planning for the erection of a new plant to provide for increased capacity.

SALEM.—The Salem Oil & Grease Company is making rapid progress in the erection of a new addition to its plant, and is planning to install new tanks and machines for preparing oils for leather tanners.

SOMERVILLE.—The Gile Marine Engine Company is making rapid progress in the construction of a new one-story machine shop, about 60 x 100 ft., to cost approximately $8.000.

SPRINGFIELD.—The Springfield Aircraft Corporation is rushing to completion the construction of the new addition to its plant on Wason Avenue. The structure will cost about $50,000.

Michigan

BUCHANAN.—The Campbell Transmission Company, 133 West Washington Street, Chicago, Ill., is planning for the construction of a new local manufacturing plant, one-story, about 60 x 230 ft., to cost $45,000. Davidson & Weiss, 53 West Jackson Boulevard, Chicago, are architects.

DETROIT.—The Guardian Motors Company has acquired property on the eastern branch of the Elizabeth River, Norfolk, Va., and plans for the erection of a large plant for the manufacture of automobiles. The initial works will consist of a reinforced-concrete structure, 100 x 500 ft., with temporary works, to be erected immediately, 50 x 100 ft. The proposed plant will have a total capacity of about 3000 cars annually. R. E. Mitchell, Norfolk, is architect.

SAGINAW.—The Northwestern Glass Company has acquired the plant of the Michigan Glass Company on Wheeler Street and will install new machinery for the manufacture of glass containers, jars, bottles, etc. It is expected to inaugurate operations before the close of the year.

Minnesota

MINNEAPOLIS.—Rapid progress is being made in the construction of the new benzol plant of the Minnesota Steel Company, and it is planned to commence operations before the close of the year.

WEST DULUTH.—The Zenith Furnace Company is having plans prepared for the construction of a new fireproof machine shop at its plant on Fifty-eighth Avenue, West. The structure is estimated to cost about $50,000.

New Jersey

CHROME.—The United States Metal Refining Company has acquired the property of the International Nickel Company, Tuffts Neck, Carteret, consisting of about 120 acres, and is planning for the erection of a new plant to provide for increased capacity. The site was secured for a consideration of about $1,200,000.

FORDS.—The National Synthetic Company, Fords, near Perth Amboy, has awarded a contract to Tullis & Blanchard, 326 East Forty-second Street, New York for the construction of three new additions to its chemical manufacturing plant, about 38 x 260 ft., 54 x 84 ft., and 50 x 76 ft. Estimated cost of the structures is $75,000.

ELIZABETH.—The Guilmette-Underwood Brass Foundry Company has inaugurated operations at its new location, 160 East Jersey Street. The company will manufacture brass and aluminum moldings, and engage in metal pattern work.

ELIZABETH.—The Barrett Company, manufacturer of roofing and building paper, tarvia, roofing and paving pitch, carbolic acid, and other coal tar products, has acquired the plant and business of the All Roofing Company, East St. Louis, Ill., and is planning for the erection of additions to the works to provide for increased capacity.

NEWARK.—Eimer & Amend, 211 Third Avenue, New York, manufacturers of chemicals, etc., have acquired a factory building at 13-17 Margaretta Street, Newark, and are planning for extensive alterations and improvements. The company is also erecting a new building at Third Avenue, between Eighteenth and Nineteenth Streets, New York, which will cost about $150,000

NEWARK.—The National Oil & Supply Company, 180 Frelinghuysen Avenue, has filed plans for the construction of a new brick and steel addition to its plant in Essex Street, to cost about $15,000.

NEWARK.—The Western Manufacturing Company has been organized to operate a plant at 615 South Nineteenth Street for the manufacture of wood chemicals.

NEWARK.—The Osborne Company, 759 Summer Avenue, manufacturer of art calendars, etc., has acquired property on Hallech Street, about 86 x 190 feet, and is said to be planning for additions to its plant.

NEWARK.—Louis Sachs, operating a foundry on Hamburg Place for the production of semi-steel castings, has awarded a contract for the erection of an addition to his plant.

NEWARK.—The Velus Rubber Company, 15 Kirk Place, has been organized to engage in the manufacture of erasers. Charles F. McChesney heads the company.

NEWARK.—The Heller & Merz Company, Hamburg Place, manufacturer of colors, dyes, etc., has awarded contracts for the erection of two new one-story brick factory buildings, about 70 x 200 ft., to cost $56.000.

NEWARK.—The Brown-Ferres Company, Inc., manufacturer of phenacetine and other chemicals, has acquired a two-story reinforced-concrete factory building on Meadow Lane from the Ezo Company. The company is planning for the immediate erection of a new building about twice the size of the one just acquired.

PATERSON.—The American Shell Company, 350 Twenty-first Avenue, has taken out a building permit for the construction of a one-story addition to its plant to cost about $13,000.

PERTH AMBOY.—The Raritan Copper Works has completed the construction of a new two-story addition to its plant, about 41 x 101 ft., and is planning for immediate occupancy. The new structure is estimated to cost about $24,000.

TRENTON.—The Delion Tire & Rubber Company is having plans prepared for extensions and improvements in its plant to cost about $18,000. J. Osborn Hunt, Trenton, is architect.

TRENTON.—The Zee-Zee Rubber Manufacturing Company has had plans prepared for the construction of a new plant at

Yardville to cost about $500,000, and the works will consist of one-story mill building, about 50 x 200 ft.; two two-story factories, 50 x 160 ft. and 40 x 125 ft., respectively; and another one-story building, about 60 x 190 ft. The company is planning for a daily capactiy of about 900 automobile tires and 5000 inner tubes.

New York

BROOKLYN.—Herman Behr & Company, 33 Tiffany Street, have awarded a contract for the erection of an addition to their sandpaper manufacturing plant to cost about $8,000. Meyer & Sweeny, 384 Crown Street, Brooklyn, is the contractor.

BROOKLYN.—Beckers Aniline & Chemical Works, Inc., East Eighty-third Street, is making rapid progress in the construction of new additions to its plant in the flatlands section. The estimated cost of the extensions is about $1,100,000.

NEW YORK.—The Stackpole Carbon Company, 71 West Broadway, has awarded a contract for the construction of a new one-story retort house, about 50 x 100 ft., at Mary's, Pa., to cost $30,000. The W. L. Goeltz Company, 50 Broad Street, New York, is the contractor.

COOK'S FALLS.—Fire recently destroyed a portion of the plant of Bine Brothers, with loss estimated at about $8,000. The company specializes in the production of sulphur colors.

GENEVA.—The United States Lens Company, manufacturer of spectacle lenses, etc., is planning for the construction of a new one-story addition to its plant, about 65 x 180 ft., to cost about $35,000. C. E. Wilson is president of the company.

MIDDLE FALLS.—A new three-story mill building, about 65 x 212 ft., will be erected by the Stevens & Thompson Paper Company at a cost of $75,000. Contract has been awarded to the Kingsbury Construction Company, Main Street, Hudson Falls.

BUFFALO.—The Great American Chemical Products Company has taken out a building permit for the construction of a new two-story reinforced-concrete factory building, about 30 x 60 ft., at South Park Avenue and Colgate Street.

BUFFALO. The Donner Union Coke Corporation is making rapid progress in the construction of its new plant in the 150-acre site on the Buffalo River, recently required.

Ohio

SANDUSKY.—The Sandusky Glass Manufacturing Company, West Monroe Street, is making extensive improvements in its plant to provide for increased capacity.

TOLEDO.—The Lewis Foundry Company, 1080 Detroit Avenue, specializing in the production of valves of all sizes, has reincorporated with a capital of $100,000 and will be known as the Lewis Steel Products Company. Two new additions to the plant have recently been completed and the company is planning for additional extensions to provide for the constantly increasing demand. At the present time the company has a daily capacity of about 15,000 gas and gasoline engine valves.

TOLEDO.—The Toledo Plate & Window Glass Company, 1014 West Eleventh Street, has acquired property on St. Clair Avenue, east of East Thirtieth Street, at a price of about $60,000, as a site for a new plant, which will be erected at a cost of $150,000. The initial construction will comprise three units to be used as finishing works, warehouse and office building. Plans are being prepared by Walker & Weeks, 1900 Euclid Avenue. George L. Heater is general manager.

TOLEDO. The Scott Machine Company has filed plans for the construction of a new one-story machine shop, about 60 x 166 ft., at West Fourteenth Street and Locust Avenue, N. W., to cost $23,000. Contract has been awarded to the William Dunbar Company, Toledo.

Oklahoma

BRISTOW.—Fires will soon be started in the new plant of the Bristow Glass Company, just completed, which will specialize in the manufacture of glass bottles. This is the second largest glass manufacturing plant in the State.

OKLAHOMA CITY.—The Miami National Lead & Zinc Company, recently incorporated with a capital of $200,000, is planning for the erection of a new 300-ton mill on a site of 80 acres, and is planning to develop about 1000 acres of land early in 1918. O. L. Farry, 110 West Grand Street, Oklahoma City, is president.

PICHER.—The Fort Worth Lead & Zinc Company, Fort Worth, Tex., is planning for the construction of a new local 2-ton concentrating plant, and will develop 20 acres of land now held on lease.

Pennsylvania

HARRISBURG. — The Pennsylvania Bronze Foundry, Seventh and Camp Streets, will build a new foundry at Seventh and Emerald Streets. The structure will be one-story brick, about 150 x 240 ft.

HARRISBURG.—The Atlantic Refining Company has secured the building of the Pennsylvania Bronze Foundry, at Seventh and Camp Streets, and will use the structure to provide for increased capacity.

NEW KENSINGTON.—Fire recently destroyed a portion of the plant of the United States Aluminum Company, a subsidiary of the Aluminum Company of America, Pittsburgh. The loss is estimated at $175,000. The plant was engaged in the manufacture of bronze powder for the Government.

PHILADELPHIA.—Contract has been awarded for the construction of a new plant at Aramingo Avenue and Huntingdon Street for John T. Lewis & Brothers Company, manufacturers of paints, etc. The works will consist of three-story mill building, brick and concrete, about 40 x 120 ft.; furnace building, 120 x 220 ft.; and one-story brick warehouse. The entire plant is estimated to cost $150,000.

PHILADELPHIA.—George D. Wetherill & Company, 114 North Front Street, manufacturers of paints, varnishes, etc., have taken out a building permit for an extension to their plant.

PITTSBURGH.—Powell & Mahan have had plans prepared for the construction of a new one-story foundry, about 15 x 150 ft., at Tulsa, Okla. The plant will be devoted to the production of brass and semi-steel castings.

SOUTH ALTOONA.—Ground has been broken by the Pennsylvania Railroad for the construction of a new plant for the purpose of mixing the lubricating oils, greases and signal oils for lines east of Pittsburgh. The plans provide for the erection of thirty-one steel storage tanks, with capacity ranging from 1000 to 125,000 gallons.

Rhode Island

PROVIDENCE.—The Providence Gas Company is perfecting arrangements to greatly enlarge one of its workshop buildings at Fields Point. The additions will provide for about 10,000 additional square feet of floor space.

Tennessee

KINGSPORT.—The Clinchfield Portland Cement Corporation has commenced work on the construction of a new potash recovery plant. The new works will employ the Cottrell or electrical precipitation system in its latest form, and will include a wet treater, by means of which potash salts will be obtained. Richard K. Meade & Company, consulting engineers, Baltimore, Md., are the designing and constructing engineers for the plant.

MUSCLE SHOALS.—Contract for the erection of the proposed new nitrate plant for the United States Government has been awarded to the J. G. White Company, 43 Exchange Place, New York.

Texas

DALLAS.—Fire recently destroyed a portion of the building of the Southwestern Paper Company's South Texas branch at Houston, with loss estimated at $75,000. It is said that the structure will be immediately rebuilt.

HOUSTON.—The Sinclair Gulf Corporation has announced that a large new oil refinery, with pipe lines and auxiliary facilities, will be constructed immediately just below Harrisburg. The refinery is estimated to cost about $6,000,000 and it is proposed to spend a total of $11,000,000 for the entire works, including all improvements. The refinery will consist of four units, and will have an initial capacity of 20,000 barrels of oil daily, being ultimately increased to 40,000 barrels daily. H. F. Sinclair is president of the company.

Utah

MIDVALE.—The Utah Iron & Steel Company has completed the construction of its new open-hearth steel plant and is planning to inaugurate operations at an early date. This includes the installation of a large electric furnace. The entire works represent an expenditure of about $250,000.

PROVO.—The Springville-Mapleton Sugar Company has acquired a site south of Springville and is planning for the immediate erection of a large sugar plant. Jesse Knight is president of the company.

SALT LAKE CITY.—The Shelley Roller Mills Company has completed the erection of its new plant and is now installing the necessary machinery. It is expected that operations will be inaugurated before the close of the year. The new mill has been constructed at a cost of about $75,000.

Virginia

BUSH BLUFF.—The Standard Oil Company is planning for extensive additions and improvements in its supply station near Norfolk, to cost approximately $2,000,000.

NORFOLK.—The Norfolk Chain Company, recently incorporated with a capital of $1,000,000, has completed plans for the construction of its proposed new plant for the manufacture of heavy chains. The works will comprise a factory building, 90 x 560 ft., and a structure about 60 x 300 ft. The main building will be equipped with hammers for welding chains, and testing machines, with auxiliary equipment. Contracts have been awarded. This company is a subsidiary of the American Chain Company of Bridgeport, Conn.

NORFOLK.—The Norfolk Tire Fabric Company is planning for the erection of a large plant, which with machinery and other equipment is estimated to cost $1,000,000. The company will specialize in the manufacture of automobile tire fabrics.

Wisconsin

EAU CLAIRE.—Rapid progress is being made in the construction of the new one-story paper mill, about 72 x 80 ft., by the Dells Paper & Pulp Company.

MILWAUKEE.—The Standard Steel Corporation, manufacturer of farm implements, is planning for the construction of a new one-story brick, concrete and steel factory building, about 60 x 200 ft., to cost about $35,000. The new addition is to provide for increased capacity.

New Publications

CHROMITE IN 1916. By J. S. Diller Mineral Resources of the United States, 1916, Part I, pp. 21-38, U. S. Geological Survey, Washington, D. C.

BAUXITE AND ALUMINUM IN 1916. By James M. Hill. Mineral Resources of the United States, Part I, pp. 159-170, U. S. Geological Survey, Washington, D. C.

THERMOELECTRIC MEASUREMENT OF CRITICAL RANGES OF PURE IRON. By Geo. K. Burgess and H. Scott. Scientific Paper, Bureau of Standards, No. 296 Washington, D. C.

MINES AND MINERAL RESOURCES OF CALIFORNIA. (a) Alpine, Inyo and Mono counties; (b) Butte, Lassen, Modoc, Sutter and Tehama counties; (c) El Dorado, Placer, Sacramento and Yuba counties; (d) Los Angeles, Orange and Riverside counties; (e) Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura counties; (f) San Bernardino and Tulare counties. State Mineralogist, Ferry Building, San Francisco, Calif.

SCIENCE REPORTS OF THE TOHOKU IMPERIAL UNIVERSITY, Prof. T. Hayashi, Librarian, Sendai, Japan. Miscellaneous contributions on mathematics, physics and chemistry, including among others, Some Properties of Annealed Steel, Transformations of Steel at High Temperatures, and Magnetic Properties of the Manganese-Antimony Alloys.

Manufacturers' Catalogs

THE COLORADO IRON WORKS COMPANY, Denver, Colo., has issued pamphlet No. 32, describing the Lowden patent dryer.

THE NEW YORK REVOLVING PORTABLE ELEVATOR CO., Jersey City, N. J., has issued Bulletin No. 42, entitled "How to Pile," describing the use of the revolvator for piling cases, bales, barrels, crated machinery, etc.

THE TITANIUM BRONZE COMPANY, INC., Niagara Falls, N. Y., has issued an attractive booklet on titanium aluminum bronze die castings.

THE WEBER SUBTERRANEAN PUMP COMPANY, New York City has issued a catalog, entitled "Pumping Water by Compressed Air."

THE ESTERLINE COMPANY, Indianapolis, Ind., has issued a bulletin describing its graphic efficiency instruments.

THE DUST RECOVERING & CONVEYING COMPANY of Cleveland, Ohio, has just issued Bulletin No. 1, describing its "Perfecto" Suction Filter, used for the recovery of solids from gases of furnace smelters, blast furnaces, and for dust-collecting in general

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Washington

It did not require the assembling of Congress to direct the nation's interest toward Washington, for in addition to its natural eminence as the political center of this country, the capital has become the industrial center of the world. One who has not visited Washington within the last few months, or who is not in some way closely in touch with affairs there, can have no adequate conception of the extent to which the capital has taken on the atmosphere of industry. Politics, in the ordinary sense, is in the background.

At this session Congress will have to deal with problems of transportation, taxation, labor, price-fixing, water power and the combination of exporters—vital issues in which every citizen is interested.

The Optical Glass Problem

One of the interesting developments in American industry due to war conditions is that a beginning is at last being made in the manufacture of optical glass. As most of our readers know, the general supply of this material heretofore has come from three great firms, one in France, one in Germany, the third in England. At the outbreak of the war practically all the product was commandeered for home use, and exports, rapidly dwindling, very soon stopped. Now that the United States is in the fight, the demand for optical glass for the manufacture of field glasses, range finders and other optical instruments necessary in war has far outrun the limited supply in stock. For a year the necessity for American manufacture has been evident.

At the present time there is good hope that the requirements may be met by home product, inasmuch as two or three large concerns have taken up the manufacture either for their own needs or for the general market. The production of optical glass is one of peculiar technical difficulties, both chemical and mechanical. It is perfectly easy to analyze the various commercial varieties of glass, but the data thus gained do not give full information as to the proportions in which the actual components must be used in the melting. Only considerable experience can give the concrete information necessary for the production of a good glass of predetermined optical properties.

Even when this information is gained, it is a well known fact that consecutive meltings of the same nominal composition may vary materially in refraction and dispersion owing to the different degrees or different ways in which the ingredients, for reasons as yet somewhat imperfectly known, actually combine. Thus in the catalogs of the great foreign optical glass works

large numbers of odd meltings not conforming strictly to type may be found listed. Curiously enough, some of these possess very valuable properties which cannot reliably be reproduced, as, for instance, a particular melting of optical crown which came to this country a few years ago and proved capable of giving an exceptionally good color-correction to the telescope objectives made from it. Again, after all the chemical problems seem to have been mastered there is the difficult mechanical task of securing suitable mixing of the materials, freedom from bubbles and streaks, and in general such physical uniformity of product as makes it possible to get pieces of considerable size and first-rate quality. Certain glasses, very valuable in the manufacture of photographic objectives, have never yet been obtained reasonably free from bubbles, and certain other varieties show an apparently unavoidable tendency to develop striæ which cannot be thoroughly worked out.

It takes courage for a manufacturer to go into this particular line of work with the determination to provide a commercial product on any considerable scale, and the country is to be congratulated on the efforts which have already been made. From one large concern at least it is now possible to get a few fundamental varieties of optical glass and there is good prospect that more are coming. One or two other organizations are working with good measure of success along the same line, but not for purposes of general supply.

The four most necessary varieties of glass, to wit, a very light and transparent crown suitable for field-glass prisms, an ordinary crown of slightly higher index, a typical heavy flint, and a typical light flint, are already in production. The two next in point of importance are a heavy baryta crown and a light baryta flint used particularly in photographic lenses, and these we learn are under way with every prospect of reaching suitable commercial development. The other necessary varieties of these several species will come along in due season, but if a good supply of well annealed material, even of the half-dozen sorts here enumerated, can be had, the country will be in pretty good shape to make its own optical instruments.

The matter of suitable mixing and annealing for the production of discs of large size may be trusted to the future, so long as the outlook for pieces of ordinary dimensions is as good as at present. The primary needs are readily met without going to large discs of the highest possible uniformity. That the problem finally will be solved we may feel reasonably certain from the results already reached, and another will have been added to the list of industries which have come to life in this country during the stress of war. The German optical-glass industry was in a sense the direct outcome of the Franco-Prussian War which inconveniently found France the chief source of supply. We hope to follow up further the developments along this line, which is of great chemical and physical interest besides being important to the prosecution of the war.

Salaries in the Teaching Profession

The president of a large university in the Middle West recently made the following interesting announcement through the press of his city:

"The majority of our instructors and professors who are responding to the call of their country are doing so at salaries greater than those they have been accustomed to receive from this university. This fact speaks volumes for the high character and scientific training possessed by the members of our faculty."

At first glance such a statement is quite sure to impress the reader with admiration for the latent possibilities of the teacher. A second reading will incite respect for a management able to provide such attractive conditions that first-class men will be willing to devote their energies to its activities, even though they might provide for themselves far better elsewhere. But after more deliberate consideration, appears a phase of the question which doubtless did not occur to the author of the statement.

We refer to the disparaging interpretation which a thinking citizen will place upon such an assertion, if he knows the various branches and ranks of the service into which the men are going. They are being commissioned as lieutenants, captains, and occasionally as majors in reserve corps. They have started at the foot of the military ladder, well knowing that there can be no hope of reaching the top, for as soon as the great conflict is over they will be relieved from active service and returned to the reserve. Men from other walks in life, scientists of equal training and experience, are accepting like commissions at enormously reduced salaries. The college instructor, on the contrary, is able to increase his modest stipend in such inferior ranks of the service. Whence, then, is a university able to draw honor and glory to herself from the publication of such a statement as quoted above?

But one might say, as did a recent editorial in *Electrical World*, "The emolument of the college teacher must be appreciably less than that which the same intelligence, energy and enterprise would probably secure in competitive professional or business life, if the teachers are to be leaders in intellectual and scholarly pursuits. If the pay of the college teacher should be recognized to be as great as or greater than that in the outside world of affairs, then the chair of professors will cease to be filled by men who esteem learning and hard intellectual work above everything else in life, and the inspiration of the colleges will cease."

In the field of engineering—and it is from this and allied professions that instructors have gone into the national service—we would utter a word of protest against the selection of teachers by such a criterion. Who, in his student days, failed to absorb inspiration, admiration and determination from a teacher who had attained recognition as a real engineer, and who could go out occasionally to devise metallurgical machinery, or to place some tottering chemical process upon its feet?

In few branches of the world's activities except teaching and the ministry is a man penalized for being in

love with his work—for possessing that prime essential to success. If, as is sometimes charged, the steadily decreasing influence of the church upon the people is due to the steadily lowering qualifications of her representatives, must not the universities of this country take adequate and immediate steps to prevent a similar trend?

Recent addresses by prominent chemists have united in pointing out the danger, not imaginary, but real, of losing our best and most inspiring men from the teaching profession through a lack of reasonable compensation. No matter how thoroughly a man believes that the molding of the young men of this country into straight-thinking citizens is the highest, most worthwhile and enduring labor one is privileged to perform, he may be absolutely forced by low teaching salaries into some other work which has the sole merit of better pay.

The warning is most timely, and deserves reiteration. The exodus of the teachers into industry is a real menace to our civilization; the average mentality of some of our college faculties appears to be decreasing; the disastrous effect upon our coming Americans is self-evident; the continued supply of inspired students is threatened. The adoption by university boards of trustees of the commercial policy of basing continued employment on fitness, coupled with the assurance of a compensation commensurate solely with the ability of the teacher, would work wonders with the efficiency, scholarship and inspiration of our engineering colleges.

Iron and Steel-Producing Capacity

The shortage of coke together with other barriers to full operation of the existing blast furnaces have prevented the output of both pig iron and steel ingots from reaching rates that would disclose the real capacity in this branch of plant equipment. Since about November 1, 1916, actual production has fallen short of the physical capacity. In pig iron there has been an actual decrease in production, while in steel ingots the increase has been less than the additional facilities completed would provide.

Production of pig iron was 19,619,522 tons in the first half of 1916, 19,815,275 tons in the second half of the year and 19,258,235 tons in the first half of this year. The production in the first half of last year represented substantially the available commercial capacity. The pig iron market was on the basis of about $18, and there were a few furnaces idle that could operate at the much higher prices since prevailing for pig iron, provided their raw materials were not correspondingly high. Production in recent months has been at approximately the average rate that obtained in the first half of last year, which means that there has been no increase by reason of idle furnaces being blown in or by reason of a dozen new furnaces that have been completed and blown in from May 13, 1916, up to date. These new furnaces should provide at least 2,000,000 tons of pig iron, and normally inefficient furnaces that ought to be able to operate when iron is high priced should account for several hundred thousand tons more, so that the average rate of production of 39,240,000 tons attained in the first half of last year should now be about 42,000,000 tons, if everything were working well. With the curtailment that began in November of last year on account of coke shortage, with other difficulties, last year's production was only 39,434,797 tons and this year's production promises to fall a shade below that amount.

There has been even more new construction of open-hearth steel furnaces than of blast furnaces. In 1916 there was practically full employment of all existing steel-making facilities, the ingot production of 41,401,917 tons (apart from the 1,371,763 tons of steel castings made) representing approximately the average capacity of the year, a capacity that probably stood at much less than the average at the beginning of the year and at much more at the close of the year. During the present year there have been further additions to capacity, and a summary made in a well informed quarter indicates that there is now in existence capacity sufficient to produce 50,000,000 tons of ingots annually. This is not a totaling of individual works capacities, as stated by their managers, such totals usually proving excessive, but an estimate based upon normal and successful working conditions. In ordinary times a blast furnace capacity of 42,000,000 tons would not support a steel ingot capacity of 50,000,000 tons. The 8,000,000 tons discrepancy, plus the pig iron used in iron and steel foundries, could not be made up by the old material, the industrial scrap, the works scrap and the roll-scale that all go to swell the ingot statistics. As industrial operations are now aligned the discrepancy could probably be made up. Pig iron consumption by iron foundries is unusually low. It is a war of steel, not cast iron. The production of works scrap is unusually high, on account of the liberal cropping required to fill war steel specifications.

The maximum rate of ingot production, 44,000,000 tons, was reached last October, but the estimated output for the current year is only 42,600,000 tons. The new year will be entered with steel ingot capacity 17 per cent in excess of this year's production, 21 per cent in excess of last year's production, and 65 per cent in excess of the production in the best year before the war. There is additional new capacity on the way, but construction work on it is practically suspended in favor of the attempt to operate the existing capacity.

What is needed, more than anything else, for full operation is a better supply of coke for the furnaces that still look to the Connellsville coke region, an assurance of continued full supply of coal for the various by-product oven plants, and a full supply of fuel for the steel works. There has been a decided shortage of Connellsville coke, first developing late in October of last year, an occasional shortage of by-product coal at some of the plants, and a severe shortage of coal at times in some of the steel producing districts, particularly the Youngstown district.

Readers' Views and Comments

The Per Cent of Cracked Gasoline Produced on Basis of Crude Petroleum and Total Gasoline Marketed In 1916 and 1917

To the Editor of Metallurgical & Chemical Engineering

SIR:—The Bureau of Mines has just given out for publication a set of highly important statistics as to the gallonage of the various products of gasoline, kerosene, fuel and lubricating oil, etc., resulting from the distillation of crude oil, marketed in 1916 and the first six months of 1917.

The writer has thought it worth while to calculate the statistics as percentages and to correlate the same with other available data upon the cracking of petroleum and to derive percentages of straight-run and cracked gasoline therefrom. *On the basis of crude petroleum refined,* 2.44 *per cent of gasoline was made by cracking and* 12.2 *per cent, or practically one-eighth of the entire gasoline sold during* 1916 *and* 1917, *was made by cracking processes.*

Table I tabulates the gallonage of gasoline, kerosene, gas, fuel and lubricating oil, and the production of wax, coke, asphalt, and loss occurring during distillation. The data indicate an increase of 16.4 per cent of crude oil refined in the year 1917, over that of 1916, on the assumption that the second half of 1917 will show the same amount of crude oil refined.

TABLE I

PRODUCTION OF PRODUCTS FROM CRUDE PETROLEUM FOR YEAR 1916 AND FIRST SIX MONTHS 1917

	Year Full, 1916	First Six Months, 1917
Crude petroleum distilled, barrels	246,076,266	143,189,374
Gasoline, gal.	2,058,322,838	1,223,379,899
Kerosene, gal.	1,455,495,732	784,411,291
Gas and fuel oil	4,290,423,757	2,697,870,034
Lubricating	624,541,195	350,358,041
Wax (lb.)	386,180,898	203,975,713
Coke (tons)	405,319	229,723
Asphaltum (tons)	715,776	319,043
Miscellaneous (gal.)	200,596,682	129,517,218
Loss in barrels	10,008,517	5,208,283

In Table II the percentage yields of distillation products for the seven sections of the United States are compared for the year 1916 and the first six months of 1917. It is interesting to compare, for example, the actual percentage yields of gasoline of the various sections of the country. There are some errors in the original data due to the incorrectness of the returns to the Bureau of Mines, but nevertheless they are good approximations. In all the fields, with the exception of the Mid-Continent (Oklahoma and Kansas), the percentage yield of gasoline increased in 1917. The average for the whole country showed a 0.4 per cent increase of gasoline on the basis of crude petroleum distilled. This increase cannot be ascribed to increased yield due to cracking of petroleum distillates, but in all likelihood is due mainly to cutting deeper into the kerosene cut in distillation of the crude oil. For it is well known that the percentages of gasoline are decreasing in the crude based upon old standards of end-point distillation. It is also well known that the end point of distillation of gasoline two years or more ago was around 300° F., whereas the end point at the present time runs around 400° F., with a strong tendency in some parts of the country to go to 500° F. The increase of the end point of gasoline allows of the use of more naphtha and kerosene as motor fuel for internal combustion engines but there is a limit to the use of higher-boiling-point cuts from crude oil with the present design of motors in automobiles, unless some radical changes are made in the design so that the higher-boiling-point distillates may be available as motor fuel.

TABLE II

PER CENT OF PRODUCTS FROM CRUDE POTROLEUM IN SEVEN SECTIONS OF THE UNITED STATES

Full Year 1916 and First Six Months 1917

Total Barrels Crude Petroleum Refined, 246,076,266 for Year 1916.
Total Barrels Crude Petroleum Refined, 143,189,374 for First Six Months 1917.

	W. Ohio, Ill., Ky., Tenn.		Okla., Kan.*		Col., Wyo.*		W. Va., N. Y., Pa., E. Ohio	
	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent
Gasoline	34.0	36.0	32.5	27.0	32.0	37.0	21.0	24.6
Kerosene	14.6	14.0	19.4	14.5	16.4	17.0	27.0	21.0
Gas and fuel oil	26.0	25.0	54.0	49.0	53.4	52.0	18.0	23.0
Lubricating oil	8.8	8.9	1.2	1.5	0.7	0.5	23.0	23.0
Wax	1.0	6.3	....	0.5	....	0.7	....	3.0
Coke	3.0	1.1	....	0.5	....	....	....	0.7
Asphalt	0.7	3.1	....	3.5	....	....	....	0.3
Miscel. oil	6.0	0.8	0.9	0.7	0.1	....	2.9	0.08
Loss	5.4	4.8	4.3	2.8	4.0	9.0	10.0	4.4

	East Coast		Texas, La.		Cal.		Average for U. S.	
	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent
Gasoline	20.7	22.0	11.0	12.0	11.0	11.0	19.9	20.3
Kerosene	22.4	22.0	9.0	11.0	4.8	4.0	14.0	13.0
Gas and fuel oil	30.0	29.0	25.0	45.0	67.0	62.0	41.5	44.0
Lubricating oil	12.6	11.0	23.6	2.7	1.5	3.0	6.0	5.8
Wax	1.0	2.0	0.7	1.0	....	2.6	1.9	2.1
Coke	2.4	1.2	2.2	1.7	....	....	1.9	1.8
Asphalt	2.4	3.0	22.7	3.3	12.0	....	3.9	4.1
Miscel. oil	2.0	2.8	0.6	20.6	2.0	....	6.9	5.6
Loss	6.3	7.0	2.0	2.7	1.6	1.4	4.0	3.6

*Values are in error; total per cent products add above 100.

CRACKED GASOLINE.

In the production of gasoline the following table is an approximation of the barrelage of cracked gasoline over the past five years.

TABLE III

CRACKED GASOLINE MARKETED OVER FIVE-YEAR PERIOD

Year	Barrels
1913	1,000,000
1914	3,000,000
1915	4,000,000
1916	6,000,000
1917	7,000,000

From Tables I and III the following percentage yield in Table IV of straight-run and cracked gasoline is shown upon the basis of total crude oil distilled.

TABLE IV

PER CENT OF STRAIGHT RUN AND CRACKED GASOLINE ON BASIS OF TOTAL CRUDE PETROLEUM REFINED

	Full Year 1916 Per Cent	First Six Months 1917 Per Cent
Straight-run gasoline	17.47	17.89
Cracked gasoline	2.43	2.44

During the last two years, of all the gasoline sold 12 per cent, or, roughly, one-eighth, was cracked gasoline. Table V tabulates the percentages of straight-run and cracked gasoline.

TABLE V
PER CENT OF STRAIGHT-RUN GASOLINE AND CRACKED GASOLINE ON BASIS OF TOTAL GASOLINE MARKETED

	Full Year 1916 Per Cent	First Six Months 1917 Per Cent
Straight-run gasoline	87.76	87.98
Cracked gasoline	12.24	12.02

From Table II it is clear that by combining the per cents of kerosene, gas and fuel oil we will have a maximum of 57 per cent of available oil for cracking purposes. It is certain that all of the 57 per cent of combined kerosene, gas and fuel oil is not suitable for conversion to gasoline. In other words, all types of oils will *not* produce gasoline economically, due to high carbon formation. Furthermore, it is well within the facts to state that not more than 60 per cent as an average of marketable gasoline can be made as a *commercial proposition* from the cracking of the 57 per cent of available kerosene, gas and fuel oil resulting from the crude oil. But is it advisable to calculate upon cracking all of the 57 per cent of kerosene, gas and fuel oil into gasoline? Would it not leave a tremendous shortage in fuel oil for industrial uses and our navy? Would it not leave a tremendous shortage in gas manufactured for lighting and heating?

To convert our kerosene, gas and fuel oil into gasoline would also cut down our toluol supply, by at least a million gallons, or a loss of 14,000,000 lb. of our most important explosive, trinitrotoluol. Is the solution of increased quantities of motor fuel a question solely of cracking petroleum oil? Or is it a question in part of radical motor design changes or motor fuel such as alcohol? Or may it be necessary to curtail all motor-car movements to war purposes only? Are we awake *nationally* to the exigencies of the motor-fuel need in our present war?

GUSTAV EGLOFF.
Independence, Kan.

Solidifying Points of Naphthalene

To the Editor of Metallurgical & Chemical Engineering

SIR:—We have taken notice of a letter written by F. H. B., published in your journal on Nov. 15, page 570, on solidifying points of naphthalene balls and flake.

We would take this opportunity of emphasizing that the solidifying point of refined naphthalene in between the ranges of 79 deg. C. and 80 deg. C., or a few decimal points above, is not always a true indication of purity of the material, as extensive investigations in our laboratories and abroad have conclusively proved. The solidifying point is really of as little indication or proof as to the positive absence of phenoloids, etc., as the acid test, since the very purest of methylnaphthalenes which has been refined from flue-gas tars has invariably a lower solidifying point than middle and heavy-oil naphthalene, although the first running of even a heavy-oil naphthalene contains frequently an appreciable percentage of methylnaphthalene. Naphthalene refined from this kind of tar (flue-gas tar) will also, no matter how carefully purified, and regardless of its pure white appearance, show a characteristic acid test, singular in its shade and darkness, while a test on phenols and cresols by means of any of the well-known methods would show no trace of these constituents.

We agree with the correspondent that the naphthalene used for the manufacture of naphthalene tablets or balls, etc., ought to be chemically pure, but we maintain that the solidifying point alone is no absolute proof of purity, nor is the acid test, for that matter. As for the naphthalene used for naphthols and amines, etc., as intermediates for dyestuffs, it is indeed very important that more stress should be laid by the refiner upon furnishing the dye manufacturer a purer material. Solidifying point alone will not prove this. Experiments carried on in our laboratories for several months past have conclusively demonstrated that the failure of some of the dyestuff manufacturers to produce some of the dyestuffs at commercially successful yields, and of less brilliancy and fastness, is not due to lack of knowledge and experience alone, but especially in the case of naphthol and amine dyes, largely due to the impurity of the bases, especially the naphthalene itself. A naphthalene of 79 deg. C. solidifying point may be all right for chlorination, sulphonation or nitration, and again it may not. We have had naphthalene under our observation, two samples of the same solidifying point and nearly the same acid test, but refined from two different tars, which gave entirely different yields on sulphonation and also different yields upon conversion into beta naphthol. The danger of a likely unsuitability of a naphathalene for the manufacture of intermediates is, however, largely removed if the naphthalene shows a solidifying point of 79.8 to 80.3. It is not very likely that there is any methylnaphthalene or foreign constituents present.

In cases where the naphthalene from water-gas tar is refined, special care must be taken, of course, to remove all traces of aliphatic hydrocarbons. These are very complex bodies and very stable toward acids and alkalies. Sulphuric acid, for instance, will attack these hydrocarbons to a certain extent, but a small but determinable amount will remain behind closely attached to the naphthalene, and almost colorless. On subliming such naphthalene a pure white brittle flake will be obtained of acceptable solidifying point and fair acid test, but so far it has been found impossible to produce any product of a solidifying point exceeding 79.3 deg. C. This material gives very unsatisfactory results on nitration and halogenation, offering considerable difficulties in purification, and losses due to bad yields.

G. V. HEYL.
Control Laboratories, F. J. Lewis Mfg. Co.,
Chicago, Ill.

Determination of Phosphorus in High-Speed Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—In the December 1, 1917, issue of your publition, appears a letter bearing the signature of W. T. Sheffield, containing implications relative to the origin and to the manner of presentation of a method for the determination of phosphorus in high-speed steels, submitted by the writer for the February 1, 1917, issue of METALLURGICAL & CHEMICAL ENGINEERING.

With respect to the originality of the method, I must admit that Mr. Sheffield's experiments considerably antedate those of the writer; with the assumption that Mr. Sheffield's date is correctly given. However, I wish to emphasize that my data were procured and my experimental work was carried out under the impression that no other similar work had been completed by any other chemist. In ascertaining the possibility of the writer's work being anticipated, many compilations of procedures for phosphorus determination in high-

speed steels were consulted and in none was the *modus operandi* the same as contemplated by the writer, especially in regard to the omission of baking in the elimination of tungsten. Furthermore, in a conversation last summer with the chief chemist of Sanderson Brothers Works at Syracuse, N. Y., the modification was discussed and no reference was made by him of a previous origin; which fact occurs to the writer as unusual in view of Mr. Sheffield's statement that his experiments were completed at the Sanderson Works.

Concerning the presentation of the writer's article in the Feb. 1, 1917, issue, it must be remarked that details of washing, filtering, etc., were omitted on the assumption that these would be supplied by the individual analyst, according to his own idea of analytical technique. In Mr. Sheffield's letter a slight inconsistency appears, occasioned by his deduction that "a brief account of the circumstances leading to the development of this modification will enable competent chemists to utilize the method as given by Mr. Kraus with perhaps a little more rapidity, accuracy and intelligence." The procedures of both Mr. Sheffield and the writer are practically the same and are outlined similarly by each.

Finally, the writer wishes it understood that he is far from detracting from the laurels of others and accords the proper credit due the Bureau of Standards men for their research in the use of sulphurous acid in phosphorus determination.

EDWARD C. KRAUS.

Dunkirk, N. Y.

Natural Gas and Other Resources of the South

To the Editor of Metallurgical & Chemical Engineering

SIR:—In view of the shortage in fuel supply and the great demand for large supplies of cheap fuel for the manufacture of chemical and other products necessary for the war and agricultural purposes, I am bringing to your attention our unusual supply of natural gas at Shreveport, which is available to large industrial consumers on a basis that makes it cheaper than water power or that derived from the use of coal.

There is now available at Shreveport about 1,000,000,000 cu. ft. of gas daily, and on the basis of scientific estimate the content of the Shreveport field is 2,000,000,000,000 cu. ft., and a very small amount of this gas is now being utilized. This estimate includes only the field as already defined, and does not consider other fields which are being opened up nearby in drilling for oil. A prominent geologist has recently stated that the Shreveport field has the largest supply of natural gas to be found in the United States.

In addition to our gas supply, we have an abundance of raw materials that are needed for war industries at this time. There is close at hand an abundance of iron, petroleum, lignite, limestone, sulphur, and salt, and generous supplies of asphalt, gypsum, kaolin, sand, gravel, clay, etc. It ought to be especially noted at this time that Louisiana has the largest deposits of sulphur and salt to be found in the United States.

ELLIS SMITH.

Shreveport, La.

Petroleum Production in California decreased nearly a million barrels in quantity in 1916 as compared with 1915, but the prices per barrel for all grades were raised so materially that the net result was an increase of $13,917,497 in total value.

The Western Metallurgical Field

American Smelting & Refining Company's Smoke Investigations

Following four years' intensive research carried out by a staff of scientists and investigators, under the direction of Dr. P. J. O'Gara, the American Smelting & Refining Company has four very high chimneys either under construction or recently completed; viz: at El Paso, Tex., 30 ft. internal diameter at the top and 400 ft. high; at Helena, Mont., 16 ft. by 400 ft., recently finished; at Tacoma, Wash., 25 ft. by 571 ft., to be finished by Jan. 1, 1918, and at Murray, Utah, 20 ft. by 450 ft., which is 30 per cent completed. The Tacoma stack when completed will be the highest in the world.

The decision to construct these stacks and their auxiliaries, e. g., flues, precipitating plants, etc., has resulted from a scientific demonstration that it is essential to discharge sulphur dioxide at as high temperature as is metallurgically possible and from as high stacks as practicable if damage to surrounding vegetation is to be avoided. Evidently the first step in such a demonstration involves the determination of the real culprit responsible for "smoke damage" to vegetation. Through an extensive series of experiments in growing plants, subjecting them to fumigations of various kinds, degrees and times, following improved methods based on those used by the Selby Smoke Commission, it was determined that sulphur dioxide alone was responsible for injury produced by so-called smelter smoke. In other words, it was shown conclusively that the visible elements of the smoke, such as flue dust and sulphuric acid mist (SO_3), had no part in producing the well-known bleaching on various types of vegetable life, so that taking the color out of the smoke, by any process whatsoever, had no effect upon lessening the danger of possible injury to vegetation. Out of this series of tests one of the most important was that which fully disproved the so-called "invisible damage theory." It was shown that actual bleaching by sulphur dioxide gas was necessary before any decrease in yield of crops was demonstrable. Various crops, including cereal, forage and root crops, were fumigated daily from the time the seedlings appeared above the ground to the day of harvest, with concentrations just below the point of visibly marking or bleaching the plants. This treatment not only did not injure these crops but actually benefited them in producing an increased yield and an increased protein content.

Susceptibility of Crops to Sulphur Dioxide

An extensive series of tests also was made in order to determine the relative susceptibility to sulphur dioxide of a large number of agricultural crops. Naturally, the important thing to know for any district is what crop or crops are most susceptible to injury by SO_2, because in any event the most resistant crops will take care of themselves if smelter operations are such as to prevent injury to the least resistant crops. For some of the least resistant crops, such as barley, oats and alfalfa, it was shown that with high relative humidity of the atmosphere (above 70 per cent), temperature above 40° F., and light values (inter-mountain districts) above 2 per cent of the maximum (this maximum being determined for clear skies with the noon sun at its greatest northern declination) one part per million by

volume (standard conditions) of sulphur dioxide will produce the first slight signs of visible markings if applied for a period of 3 hours. It was also demonstrated that the effect was of the same order if the fumigation was continuous or consisted of a series of puffs of various sulphur dioxide content averaging the former condition. If the time element is increased, all other factors remaining the same, the concentration of SO_2 necessary to produce the same degree of injury must be less; if the time element is shortened the SO_2 concentration must be greater.

At the same time thousands of determinations were made of sulphur dioxide content of the atmosphere at various distances to the lee of the smelters, all readings being accurate to one part in 10 millions of air by volume. Simultaneous readings of stack temperatures and volumes were made and in addition analysis of flue gases. From these data concentration-distance curves were plotted which demonstrated, among many other things, first, that the distance from the stack of the highest sulphur dioxide concentration was greater for higher stacks and hotter gases; second, that the maximum sulphur dioxide concentration varied directly as the amount of sulphur eliminated and inversely as the height of the chimney and the temperature of the gases. Putting it in another way, for low stacks the highest concentration of sulphur dioxide in the smoke stream is nearer the stack than it is in the case of high stacks, with temperatures, volumes and sulphur dioxide concentrations remaining the same. However, the highest concentration or point of maximum for the high stack is lower in proportion to the height of the stack. If the higher stack were twice as high as the low stack then we would expect the point of maximum concentration in the smoke stream to be at twice the distance that it is in the low stack and to have a maximum concentration of sulphur dioxide of only one-fourth that of the low stack.

Limit of SO_2 Concentration in Smoke Stream

Theoretically, therefore, if a smelter operation requires the elimination of a given number of tons of sulphur a day it should be possible to predict a stack height and temperature which will produce a concentration-distance curve having a limiting maximum SO_2 content so that no injury could result therefrom. It has been found that the safe limit of average concentration in the smoke stream must not be more than 3/10 of a part per million of sulphur dioxide in order that the region may be safe from visible markings on the most susceptible vegetation. The reason for stating that an average of 3/10 part per million should be the limiting concentration is based upon the findings that when an average of 3/10 of a part per million was found in a smoke stream, under certain conditions the maximum hourly concentration reached three times that amount, or a little less than one part per million. Failing a stack which will meet the above conditions, close watch on the sulphur dioxide elimination must be kept on days of prevalent winds when the relative atmospheric humidity is high and when the temperature is above 40° F., so that injury to surrounding vegetation may not result because of high sulphur dioxide content of the smoke stream. Injuries due to sulphur dioxide from smelter stacks do not occur generally, but under conditions named above when there is a coincidence of the factors of temperature, light, high relative humidity and wind constancy or prevalency. When such coincidences do occur and it is known that the sulphur dioxide content of the smoke stream is sufficiently high to produce damage, shutting down some of the furnaces is the only alternative if injury is to be averted. This "weather eye" smelter-management is evidently easier in a lead smelter than in a copper plant, for the ordinary Dwight and Lloyd roasters are easily started and stopped, and the sinter may be made during the night in sufficient extra quantity for operating the blast furnaces through the day—the calcine being charged cold as usual. This night operation of the roasters, even greatly in excess of the day operation, is suggested because plants are known to be more resistant during the hours of darkness. In general, most field crops are from 5 to 6 times as resistant at night as they are in the daytime, all other factors remaining the same.

Electric Precipitation of Solids

Since hot smelter smoke rises higher and diffuses so much more readily than colder smoke the Cottrell process is supplanting the baghouse for clarifying the gases from solids. Baghouse operation depends upon relatively low temperatures, 200° F. or thereabouts. Hence in general a great deal of potential energy (heat) must be taken out of the roaster gases if they are to be sent more or less directly through the baghouse—loss of potential energy (heat) simply means that the height to which such cooled gases will rise will be proportionate to the amount of heat remaining in them. The Cottrell process of clearance permits much higher gas temperatures, thus supplanting the baghouse, but the heat thus gained may be insufficient to provide proper diffusion of the huge quantities of sulphur liberated by the larger smelters, even with stacks approaching the constructional limit in bulk, height and expense. In such cases the large plant must either break up into small, isolated units or else install methods for the elimination of excess sulphur from the "smoke stream"—a sulphuric acid plant, as at Garfield, Utah; a liquid sulphur dioxide plant, as at Tacoma, Wash.; or a thiogen or other proposed process which may prove practicable. In any event, the maximum safe elimination of sulphur as sulphur dioxide should be determined and in no case should this maximum be exceeded where injury to vegetation is to be reckoned with. The maximum amount of sulphur that may be eliminated will naturally depend upon local conditions, such as the climatological factors and topography as well as upon the temperature of the gases and the stack height.

Perkin Medal Award

The Perkin Medal Committee, consisting of members of the various chemical societies, has awarded the Perkin Medal for 1918 to Auguste J. Rossi of Niagara Falls, New York, in recognition of his work on titanium. The Perkin Medal was founded in 1906 by the New York Section of the Society of Chemical Industry to commemorate Sir William Perkin, the inventor of mauve. The meeting of the New York Section of the Society of Chemical Industry at which the presentation will take place will be held on Jan. 18 at the Chemists' Club in New York.

St. Louis Meeting of American Institute of Chemical Engineers

The tenth annual meeting of the American Institute of Chemical Engineers was held in St. Louis Dec. 5 to 8. Headquarters were at Hotel Statler. As the local section of the American Chemical Society participated in the meeting throughout, the chairman of the section, Mr. A. C. Boylston, assisted President G. W. Thompson in conducting the sessions of the meeting.

The address of welcome to St. Louis at the opening session was delivered by Mr. Wm. T. Findly, representing Honorable Henry W. Kiel, Mayor of St. Louis. President Thompson responded to the address of welcome. The following officers were elected: G. W. Thompson, president; J. C. Olsen, secretary; F. W. Frerichs, treasurer; M. Toch, auditor; A. W. Smith, T. B. Wagner and D. Wesson, directors.

The secretary reported the membership of the institute as 283, consisting of one honorary member, 241 active and forty-one junior members, an increase of twenty-eight active and five junior members during the past year.

The first paper on the program at the opening session was on "The Relation between Efficiency of Refrigerating Plants and the Purity of Their Ammonia Charge," by Dr. F. W. Frerichs of St. Louis. In a preliminary statement Dr. Frerichs stated that a large amount of ammonium nitrate is required for the manufacture of explosives and that most of the ammonia obtained from the by-product coke oven plants is in the form of ammonium sulphate.

There is only one plant in the United States, namely that of Herf & Frerichs in St. Louis, in which aqua ammonia can be made from ammonium sulphate, and this plant is engaged in producing liquid ammonia for the refrigerating industry. Upon request of the Food Administration of the United States, the capacity of this plant is being increased 50 per cent in order to secure an ample supply of liquid ammonia for the cold storage warehouses and the ice plants so as to conserve the food supply.

In order to obtain an adequate supply of aqua ammonia for the manufacture of ammonium nitrate for the manufacture of explosives, Dr. Frerichs had been requested by the United States Government to erect eight new plants the size of the St. Louis plant at various points. Dr. Frerichs had generously offered the government complete plans and specifications and the use of his patents for the duration of the war, the plants to be dismantled at the close of the war. Publication of Dr. Frerichs' paper is reserved for a later issue.

A paper by Wm. M. Booth of Syracuse, N. Y., on "Distilled Water" was then read.

Wednesday afternoon members of the institute and members of the St. Louis section of the American Chemical Society proceeded by automobile to the very large ice plant of the Anheuser Busch Brewing Association. This plant has a capacity of 1200 tons of ice per day and is the largest plant of its kind in the world.

The party then proceeded to the plant of the Herf & Frerichs Chemical Works. Construction work was here going on both on the extension of the ammonium sulphate plant and on a new plant designed to use ammonia liquors from gas works.

The party then visited the by-product coking plant of the Laclede Gas Light Company.

On Wednesday evening the members of the institute and members of the local section of the American Chemical Society took dinner at the St. Louis Club as the guests of Dr. F. W. Frerichs. The very handsome clubhouse was very much admired. The dinner was held in the spacious dining room on the second floor, which was beautifully decorated with flags. Covers were spread for about eighty.

Thursday morning the party proceeded by automobile from Hotel Statler to the city water works. Mr. E. E. Wall, Water Commissioner of the City of St. Louis, explained the history of the development of water purification in St. Louis and gave an outline of the process employed for purifying water.

The party then proceeded to the Riverside Club, where luncheon was served in the spacious and beautifully decorated dancing pavilion of the club.

After luncheon the party was taken by automobile to Granite City where the plant of the National Enameling & Stamping Company was visited.

On Thursday evening a joint meeting with the local section was held at Hotel Statler. A paper by Gaston Du Bois of the local section on "Engineering and Chemical Works" was first read.

A paper on "Organization of Chemical Companies" was read by Mr. Frank Hemingway.

On Friday morning the members and their guests left the Hotel Statler by automobile for the plant of the Commercial Acid Company.

Some of the members then visited the plant of the Laclede Christy Fire Clay Company.

During the forenoon, three papers were read on the general subject of evaporation and drying. Mr. Hugh K. Moore of Berlin Mills, N. H., read the first paper on "Some General Aspects of Evaporation and Drying."

Mr. F. M. de Beers read the paper on "Some Problems in Evaporation and Drying," presented by Mr. P. B. Sadtler and F. M. de Beers.

Mr. H. McCormack of Chicago read a paper on "Evaporation and Drying of Tannin Extracts by the Carden Process."

On Friday evening the subscription dinner was held at Hotel Statler. The attendance of sixty-three was about equally divided between members of the institute and members of the American Chemical Society.

President Thompson acted as toastmaster and the speakers were Alexander S. Landsdorf, Professor of Electrical Engineering and Dean of the School of Engineering of Washington University; Dr. B. M. Duggar of Shaws Garden, Secretary Olsen and Dr. Charles E. Caspari.

On Saturday the plant of the National Lead Company at Collinsville, Mo., was visited, the mechanical furnace being of special interest to those who made the trip. A private parlor car had been provided for the trip. A special program had been arranged by the local Ladies' Committee under the chairmanship of Mrs. A. A. L. Veillon for the entertainment of the visiting ladies. The St. Louis members proved to be very royal hosts, and the members of the institute were interested to find so many important chemical industries in this locality.

Faraday Society Symposium on Pyrometers and Pyrometry

At a meeting of the Faraday Society held in London Nov. 7, 1917, the general subject of pyrometers and pyrometry was considered in its relation to metallurgy. In addition to the program, which we abstract below, there was an exhibit of instruments by United States and British manufacturers. The first paper presented dealt with the

Production of High Temperature and Its Measurement

BY E. F. NORTHRUP

The author first shows that the refractory properties of carbon offer means of attaining high temperatures, the upper limit of which is the vaporization temperature of that element. Carbon, however, offers an incomplete solution of the problem of attaining high temperatures for heat-treatment of materials, due to the fact that at the temperatures exceeding that obtainable in a platinum-wound furnace, carbon enters into chemical combination with a large number of elements and reduces many chemical compounds.

The difficult and highly important problem for solution is the attainment of chemical purity at very high temperatures.

Another consideration to be touched upon here is that of the inherent thermal inefficiency of every type of resistor furnace when used for producing fusion of a product which melts at a high temperature. The character of the results obtained becomes at once apparent if we consider a special case. Assume we wish to melt with efficiency a nichrome-wound furnace a given mass of copper. The copper would be contained in a graphite crucible, which would be placed in a Norton alundum tube wound on the outside with nichrome wire. Outside the wire-wound tube there would be a cylinder of the best obtainable heat-insulating material with a radial thickness of several centimeters. With this arrangement the heat generated in the wire must travel to reach the copper through, say, 0.5 cm. of heat-insulating material and to reach the outer wall of the furnace through, say, 10 cm. of heat-insulating material. Assume, when the current is first turned on, that the nichrome wire quickly attains its maximum safe temperature of, say, 1282 deg. C., and that at this first moment the copper and the outer wall of the furnace are both at 0 deg C. The temperature gradient, from wire to copper and from wire to outer furnace wall will now be the same. But since the insulation thickness which must be passed through for heat to reach the copper is but one-twentieth that which it must pass through to reach the outer furnace wall, heat will flow approximately twenty times as fast into the copper as it does toward the outer wall of the furnace. By this rapid inflow of heat into the copper the metal will soon be brought, though at a slower and slower rate, to its fusion temperature of 1082 deg. C. But at this stage the temperature gradient from wire to copper has become reduced to 1282 — 1082 = 200 deg. C., while from the wire to the outer furnace wall the gradient remains, as at the beginning, 1282 deg. C. It follows that the ratio of the inflow to the outflow of heat is now greatly diminished, and that the heat which must be given to the copper to furnish its latent heat of fusion to melt it is but slowly supplied under a gradient of only 200 deg. Thus the heat available for fusion may become but a small fraction of the total heat generated in the furnace winding. The efficiency of the furnace as a *melting* furnace is, therefore, low, and if the furnace charge consists of a metal which fuses at just the maximum temperature to which the resistor may be brought, the efficiency of the furnace *for melting* becomes zero. A tubular resistor-type furnace will give in an empty chamber a high temperature very quickly, but it is, on the other hand, an inherently inefficient fusion furnace, which becomes rapidly more inefficient as the temperature required for fusion approaches the safe operating temperature of the resistor heater.

The above rather discouraging considerations led the writer to make two inquiries: first, what form would an ideal furnace take, and, second, is it physically possible to reach this ideal electrically?

Conception of an Ideal Furnace

The writer's conception of the ideal melting furnace is one which consists of a crucible of cylindrical form (so proportioned that the ratio of its radiating surface to its volume is a minimum) that contains the product to be melted, either electrically conducting or insulating. This product by induction alone should be capable of absorbing a large percentage of the power available, and thereby become quickly and uniformly heated until fusion with any desired superheat is obtained. The heat supplied in this ideal furnace should first and only make its appearance directly in the walls of the crucible, or, better, within the contents of the crucible. As power is continually supplied the temperature should rise and loss of heat by outward conduction and radiation should be negligible. The final possible temperature attainable should not be lower than a necessary limit set by the refractory properties of the crucible itself. A large percentage of the power supplied electrically and metered at its source should become directly transformed *within* the crucible into heat and not *pass* into the crucible from the outside by a process of heat conduction.

If this ideal furnace is to be in part or wholly realized it must be by some form of induction, obtained without the use of iron, for reasons which appear below.

The customary form of construction of the induction furnace does not permit the attainment of this ideal furnace in several particulars:

1. An electric circuit and an iron magnetic circuit are always interlinked. Thus, a circuit of metal is always interlinked with a complete or an approximate circuit of iron. This latter carries a primary winding, and the circuit of metal constitutes the secondary of a step-down transformer. This threading through the electric circuit of an iron magnetic circuit precludes the possibility of realizing the simple crucible form of construction above described.

2. The difference between the expansion with temperature of metals and refractories makes it practically impossible, without destroying the latter, to allow the ordinary induction furnace to cool down to where its charge solidifies. Refractory linings are invariably cracked when this is done. The furnace must be started with pre-melted material, and its charge must be removed before it is allowed to freeze.

3. The induction furnace constitutes a step-down transformer which necessarily has large magnetic leakage. The power factor may, therefore, be very low, the supply current lagging behind its e.m.f.

4. Very high temperatures cannot be obtained in the ordinary type of induction furnace because, if energy is supplied fast enough to replace the heat losses at high temperature, the molten material is ruptured by the mutual attraction of current elements. The limit is set for obtaining high temperatures by what Dr. Carl Hering has called the "pinch effect."

5. The ordinary induction furnace does not lend itself to such form of construction that the contents may be heated in controllable atmospheres or in vacuum.

With these limitations of the ordinary induction furnace in mind, the writer sought the underlying principle which would permit the attainment by electric induction of the ideal type of simple crucible furnace. This principle has been found, and a 20-kw. furnace embodying the principle has been made and very thoroughly studied. The furnace is a complete success. The principle upon which it operates will now be very briefly described.

Principle of Operation

Heating is obtained by inducing, with comparatively high frequency currents in an inductor coil which surrounds the crucible, very large currents in the walls of the crucible or in its contents, if these are electrically conducting. The induction is obtained by electromagnetic induction without the use of any iron. The furnace differs radically from all other types of induction furnace by the entire absence of any interlinkage of a magnetic with an electric circuit. The necessary high frequency of the inducing current may be obtained in more ways than one. The simplest and most obvious method is to employ oscillatory currents obtained from the discharge of condensers. These oscillatory currents pass through an inductor coil of about fifty turns which surrounds the crucible, and sufficiently separated from it to permit of both electrical and heat insulation. We thus have in effect a Tesla coil arrangement in which the voltage is transformed down and the current transformed up. It is to be noted that when a condenser of capacity C is charged to voltage V, energy is stored in the dielectric in potential form and in amount $\frac{1}{2}CV^2$. When the condenser is discharged this potential energy is released, and, becoming kinetic, may take the form of electric radiation as utilized in radio practice, or it may take the form of thermal energy or heat. When this principle is once recognized it becomes purely a question of design and engineering practice so to construct apparatus and select conditions that very little energy is spent in radiation and a large percentage of energy is converted into heat within a crucible and its contents—the necessity of the interlinkage of an iron magnetic circuit with an electric circuit being entirely obviated.

Apparatus consisting of adjustable reactances, high tension transformers, and an entirely new type of discharge gap (which is nearly silent and operates without moving parts), two blanks of condensers and a furnace inductor winding, constitutes a complete outfit for operation on a two-phase, 60-cycle, 220-volt supply circuit.

Fig. 1 is a general view of an assembler 20-kw. furnace of the vacuum type.

Fig. 2 shows a metal-melting furnace with its outer protecting case removed to reveal its construction.

The results so far obtained with this furnace (which is considered only as a model, since it is contemplated to construct this type of furnace in 50 or 60-kw. units) are about as follows:

1. It operates on a two-phase circuit, drawing an equal load from each phase.

2. It operates at full load with unity power factor for the supply circuit or with a slightly leading current.

3. It operates at any small fraction of full load without appreciable reduction in efficiency.

4. The metal-melting furnace will melt, starting at room temperature, about 45 lb. of brass in thirty-five minutes when watt-hour meters in the supply mains register a total power supplied of 18 kw.

5. The vacuum-type furnace, illustrated in Fig. 1, will bring a crucible of Acheson graphite 14 cm. in diameter and 18 cm. high, filled with tin or glass, to a temperature of well over 1600 deg. C. in forty to fifty minutes, and a vacuum of not less than 1 cm. of mercury can be maintained during the process. It should be stated, however, that certain kinds of glass evolve a

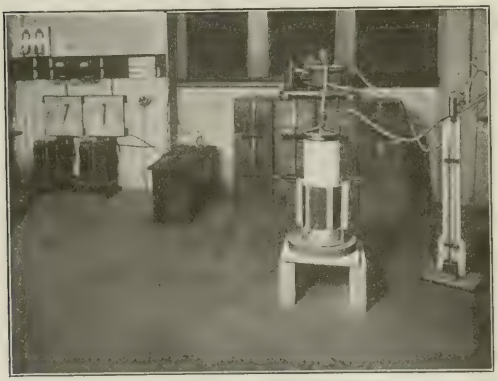

FIG. 1. NORTHRUP-AJAX HIGH FREQUENCY INDUCTION FURNACE. GENERAL VIEW OF VACUUM TYPE

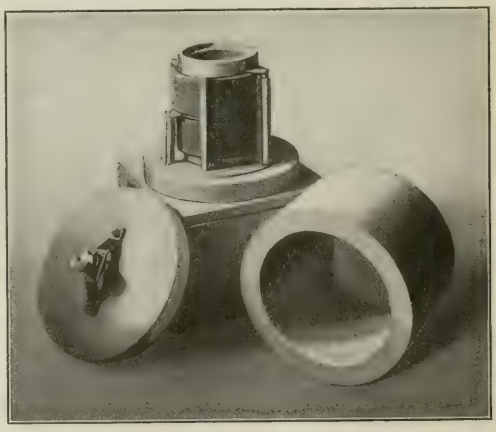

FIG. 2. NORTHRUP-AJAX FURNACE. METAL MELTING TYPE

vapor under reduced pressure which diminishes the vacuum and makes the glass frothy.

6. Cylinders or crucibles of the above dimensions or smaller, made of graphite can be raised to a temperature of 1600 deg. C. with an almost perfect uniformity in their temperature distribution. Cylinders of other materials, as of iron, nickel, or nichrome, may be raised in temperature until they start to melt.

7. The thermal efficiency, defined as the ratio of heat energy developed within the crucible and its contents to kilowatt hours supplied at switch terminals (both expressed in like units), may be made as high as 60 per cent with the 20-kw. furnace illustrated, and it is thought that a greater thermal efficiency may be obtained in a furnace of larger power capacity.

The melting of platinum in vacuum has not yet been accomplished, but it is expected that this result will be attained when certain required devices have been constructed.

Progress in Electric Heating

It is to be noted here that as progress in power and lighting distribution has come with increase in line voltage, so we may expect progress in electric heating by utilizing higher voltages. The progress already attained has been reached by heating with induction at high voltage, and only a beginning has been made in a direction which gives rich promise of further development.

The furnace here illustrated has been operated at 5400 and at 7200 volts at the condenser terminals. The frequency is the natural period of the oscillatory circuit of either phase. About equally good results have been obtained when working with 25,400 cycles and with 12,500 cycles per second.

Protection from the high voltage is secured by surrounding the furnace casing with a grounded metal cage, and the crucible, in addition to being electrically insulated from the inductor coil with a cylinder of quartz glass, is likewise grounded.

The furnace above described and illustrated comes very near to a realization of the "ideal furnace" which we have pictured.

This furnace was developed by the writer for, and with the financial support of, the Ajax Metal Company of Philadelphia, Pa. The development was made in, and with the facilities of, the Palmer Physical Laboratory of Princeton University.

The early construction of furnaces of larger kilowatt capacity is under contemplation. These furnaces should be particularly adapted to the melting of optical glass, high melting alloys, brass, gold, silver, etc.

It has been shown experimentally that by means of electromagnetic induction at high frequency, metal scrap, borings, turnings, etc., may be quickly raised to a melting temperature, then fused and superheated, even when contained in a refractory crucible of non-conducting material. Currents circulate in the subdivided mass, jumping with unnumerable small arcs the contact resistances between particles. In this manner pure electrolytic iron, contained in a magnesia crucible, has been fused in vacuum, carbon and presumably every other source of contamination being entirely absent.

Finally, it is worthy of statement that we have in this method of heating a type of furnace which it is impossible to destroy by burning out, as the only parts which get at all hot are the crucible, its contents, and the immediate layers of refractory lining. A layer of heat insulation of "silox" about 1 cm. thick surrounds the crucible, and this has been found quite sufficient to maintain the inductor coil below a red heat when the crucible and its contents are above 1400 deg. C.

It is hoped that eventually, by using greater power input, it will be possible to melt metals in vacuum belonging to the tungsten group, and therefore make it possible to produce, free from carbon, any kind of very high melting alloy.

The Measurement of High Temperature

We must here confine our remarks to the measurement of high temperature by means of direct insertion pyrometers, excluding from consideration the extensive subjects of radiation and optical pyrometry.

The limits to accuracy set for high-temperature direct-insertion pyrometers are determined chiefly by the inevitable chemical modification of the pyrometric substance rather than by its fusion or destruction. With the best types of pyrometer-casing tubes which are at present obtainable, at a temperature in the neighborhood of 1350 deg. C. gases obtain access to the thermocouple wires, and contamination is produced by the chemical activity of the hot gases. If the pyrometer is inserted in a reducing atmosphere, this contamination is particularly marked. Thus the writer has never been able to use successfully, except for very intermittent service, a platinum-rhodium thermocouple in a reducing atmosphere much above the melting point of nickel. A thermocouple of tungsten-molybdenum, though giving but a feeble e.m.f., can be used to measure extreme temperatures if it can be protected from access of hot gases.

Up to about 1300 deg. C. the accurate measurement of temperature in any kind of atmosphere has been satisfactorily solved by properly constructed and protected platinum-rhodium thermocouples, the e.m.f. of which is determined by a potentiometer method. As a potentiometer is a somewhat delicate instrument to take into the factory, and as a direct deflection galvanometer, or millivoltmeter, must be intrinsically sensitive to measure the feeble e.m.f. of a platinum-rhodium couple, the writer deemed it highly desirable to

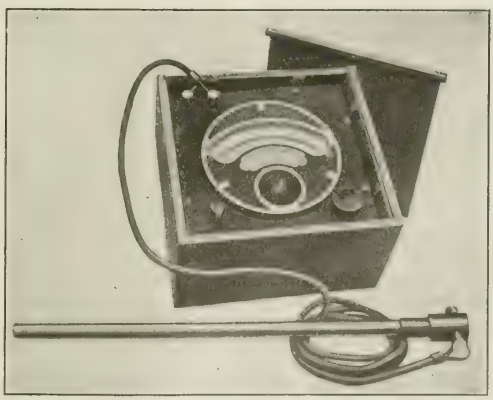

FIG. 3. PYROVOLTER. COMPLETE WITH SPECIAL THERMOCOUPLE

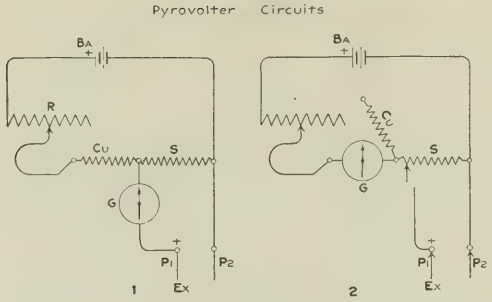

FIG. 4

devise a robust portable instrument which would operate on the potentiometer principle, but give readings in millivolts or degrees by the deflection of a pointer. The instrument devised for this purpose has the appearance and all the rugged characteristics of a voltmeter. It is marketed under the name "Northrup Pyrovolter." The instrument is illustrated in Fig. 3.

The principle upon which the pyrovolter operates may be very briefly described as follows:

Referring to Diagram I, Fig. 4, a small dry cell *B*A, contained in the case of the instrument, sends a current through the rheostat *R* and the fixed resistances *C*U (which is equal in value to the resistance of the copper coil of the moving element of the meter *G*), and *S*, a fixed resistance of manganin adjusted accurately with potential tap offs. The value of the resistance included between these potential leads determines the range of the instrument. The current flowing through *S* is varied by the rheostat *R*, so that a varying e.m.f. is applied to these potential leads due to the drop of potential over the resistance *S*. The moving element is connected in series with the unknown e.m.f., *E*x (through the binding posts P_1 and P_2), across this varying potential, so that the meter serves as a galvanometer to establish a balance between the unknown *E*x and the drop across *S*. This adjustment is effected by turning the large black button (marked "Off") in the lower right corner of the instrument, in a clockwise direction, to increase the current flow through *S*, thus increasing the drop across *S*. When the balance has been attained, as is shown by the pointer of the instrument resting over the extreme left end of the scale (where a long, fine line is drawn to assist in setting the pointer accurately for this balance), the small button in the lower left corner of the instrument is pressed, which changes the connections to those of Diagram 2.

In the new connections (Diagram 2), it will be noted that the pressing of the button has substituted the meter *G* for the resistance *C*u. This substitution is permissible for all temperatures, since both elements are copper and hence always of the same resistance; so that now without affecting the conditions of the circuits, there has been introduced a meter which measures the current flowing through *S*, and since the drop across *S* is proportional to the current flowing through *S*, the scale of the meter is marked off to read the drop across *S*, and this drop having been just balanced against *E*x, we have the instrument indicating the value of *E*x.

In effect, the pyrovolter principle provides a means of operating a deflection instrument on the potentiometer principle, wherein the accuracy and permanence of the instrument basically depend upon a permanent magnet rather than upon a standard cell, in that the "current constant" of the instrument is all that affects the readings, the resistance *S* being once fixed. The practicability of the principle is at once evident, since the permanence of a permanent magnet is the basis of the calibration of the instrument.

Some of the advantages secured with this type of instrument for measuring millivolts by reading a deflection, and consequently the corresponding temperature indicated by either a base or noble metal thermocouple, may be enumerated as follows: Sufficient sensibility is secured in a rugged instrument so that temperatures indicated with platinum-rhodium couples may be read with satisfactory accuracy. As the instrument operates on a potentiometer principle, the resistance of the thermocouple itself and the thermocouple leads may vary within wide limits without affecting the accuracy of the readings. The instrument is not limited to a single range, but as many as four ranges may be conveniently embodied in one instrument. The indications of the pyrovolter are theoretically and practically independent of the temperature coefficient of the instrument itself.

Though thermocouple methods of reading temperatures meet most of the requirements of laboratory and factory up to the safe working temperature limit of the platinum-rhodium couple, there are many industrial operations, carried on at higher temperatures, where a direct-insertion pyrometer which measures these accurately would be very welcome.

Nature has provided us with a pyrometric substance which promises to give the result desired. This pyrometric substance is the metal tin. It possesses among the metals some unique characteristics. Tin melts at 232 deg. C., and the writer knows from personal study that it does not evaporate appreciably nor boil at 1680 deg. C. According to a determination by Greenwood[1] its boiling point is 2270 deg. C. Thus the range of temperature in which tin is molten, about 2000 deg. C., is greater than that of any other known substance. Tin does not form a carbide in the presence of graphite, and maintains its purity in an atmosphere of CO at the highest temperature at which it is molten. To these properties are added others which particularly adapt it to pyrometric uses. Thus, it increases in resistivity when in the molten state, and also in volume in a strictly linear manner within increase of temperature. At least this is true up to the highest temperature at which accurate observations have been made, which is 1680 deg. C.

The writer has taken advantage of these characteristics of pure tin for measuring temperatures above 1600 deg. C. and as low as the solidification-point of tin. He has used a method employing the increase in the resistivity of tin with temperature, and has developed in this connection an instrument called a "resistometer."[2] More recently he has developed a tin-pyrometer which depends for its indication upon the linear expansion of tin. The instrument is constructed on

[1] *Chemical News*, 100, 1909.

[2] "New Method of Measuring Resistivity of Molten Materials: Results for Certain Alloys," by E. F. Northrup and R. G. Sherwood, *Journal of the Franklin Institute*, October, 1916.

the general lines of a very large mercury thermometer. A first instrument which was recently constructed for industrial use to measure the temperature of a brick furnace is illustrated in Fig. 5. The pyrometer is shown in cross-section in Fig. 6.

The tin is contained in a "bulb" of close-grained graphite, and it expands, when the temperature exceeds about 700 deg. C., into the graphite "stem." The height at which the column of tin stands is determined, in the present form of instrument, by electrical contact. The scale is laid off or calibrated by noting the height of the column of tin at some two temperatures chosen within the range of a platinum-rhodium couple. The scale is extended above the higher temperature upon the assumption that the expansion continues linear to the highest temperature for which the combination, graphite and tin, is suitable. The upper obtainable limit of temperature to which it is practical to go has not been actually determined, but it is known from personal observation that this limit is higher than 1680 deg. C., and it is thought to lie well above 1800 deg. C.

This pyrometer does not indicate, as a thermocouple does, a point-temperature, but registers the mean temperature over the space occupied by the pyrometer bulb.

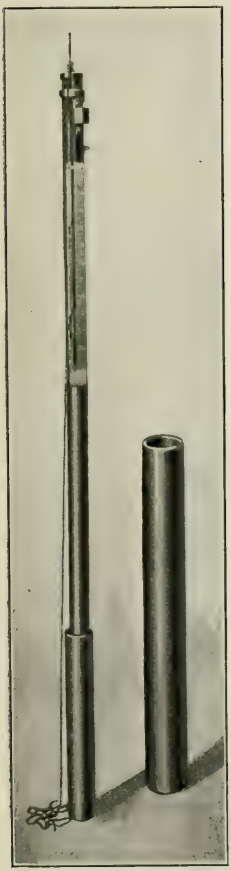

FIG. 5. TIN PYROMETER AND OUTER CASING TUBE

There does not appear to be any serious difficulty in sight in preventing the graphite from oxidizing and slowly wasting away. To prevent this it is proposed to inclose the bulb and a portion of the stem in a tube closed at the bottom of a carborundum composition ("refrax," "silfrax" or "carbofrax," as made by the Carborundum Company of Niagara Falls). In the small clearance space between the bulb and the inside of this tube there may be inserted a filling of molten tin or a high-melting glass. This jacket of molten tin or glass is expected to make a perfect shield against the attack of oxidizing gases upon the graphite of the bulb. Of course, this type of pyrometer is intended only for permanent installation in an industrial furnace of comparatively large dimensions, and the tin-pyrometer as now constructed must be maintained approximately in a vertical position.

It should be stated that while the writer has the highest confidence in the future practical application of this very high temperature direct-insertion pyrometer, it has not, at the present writing, been tried out in industrial situations, so that it may be pronounced a proved commercial success—but the principle is correct and further developments are quite sure to follow.

In closing, the writer would urge upon all investigators in the field of high temperature to consider the great possibilities of the metal tin for extending the fundamental temperature scale above 1550 deg. C., the present limit of the gas thermometer. Tin can be obtained as pure as nitrogen gas, and when in the molten state is quite as independent as a gas of its past physical history. Only chemical contamination and temperature can affect either its resistance-change or its volume-expansion, and its chemical purity is easily controlled. Its resistance-increase and its expansion characteristics are, we firmly believe, as regular as is the increase in pressure of a gas of constant volume when its temperature is increased. Pure graphite, which makes an ideal container for tin, has an almost negligible expansion, and it is certain that both tin and graphite are undisturbed by a temperature elevation which goes far beyond that at which any gas can be used pyrometrically.

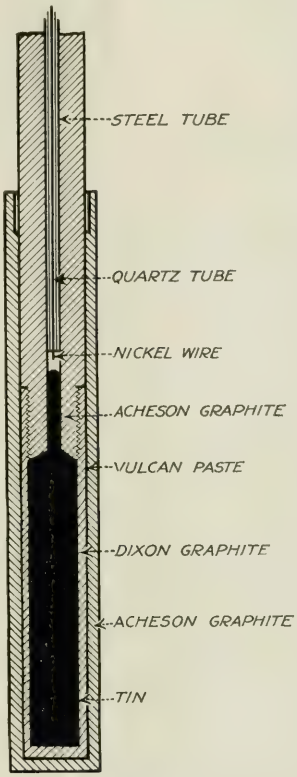

FIG. 6. CROSS SECTION OF TIN PYROMETER

Pyrolectric Instrument Co.,
Trenton, N. J.

Pyrometer Standardization

This subject was discussed by Messrs. EZER GRIFFITHS and F. H. SCHOFIELD of the National Physical Laboratory. The authors state it is now generally agreed that the standard scale of temperature should be the thermodynamic. The advantage of this from the practical point of view is that it permits of the evaluation of high temperatures, on the basis of the radiation laws, on a scale consistent with that obtained by means of the gas thermometer at lower temperatures. The problem of pyrometer standardization resolves itself to an empirical calibration of the pyrometer, whether mercurial, thermo-electrical, or radiation, by comparison with a gas thermometer. The steps by which the scale of a pyrometer is obtained are generally as follows: (1)

The gas-thermometer worker makes a comparison of his instrument with a thermo-element. (2) This calibrated thermo-element is then employed to determine the freezing points of a number of pure metals. (3) The observer who wishes to calibrate a pyrometer standardizes a thermo-element by freezing-point determinations, assuming the values given by the gas-thermometer worker for these transition points. (4) The pyrometer and thermo-element are then compared under suitable conditions. Examples of this procedure are given in the paper.

The Automatic Control and Measurement of High Temperatures

BY RICHARD P. BROWN

The author shows the industrial need of methods of automatic temperature control and the feeling of security that comes to a works manager whose plant is thus equipped. His experience shows that for temperature measurements up to 800 deg. Fahr. or 425 deg. C., an instrument actuated by the expansion of nitrogen gas is most satisfactory.

For use at moderate temperatures, where the measuring instrument must be placed at a considerable distance and for temperatures above the range of the gas expansion instrument, the thermo-electric pyrometer has been almost universally adopted in the United States. A thermo-couple of base metals, usually formed of one wire of 90 per cent nickel and 10 per cent chromium, and the other wire 98 per cent nickel and 2 per cent aluminium, is preferred for temperatures up to 1800 deg. Fahr. or 1000 deg. C. For temperatures above this, and as high as 2800 deg. Fahr. or 1500 deg. C., thermo-electric pyrometers using a platinum-rhodium thermo-couple are the most satisfactory. For higher temperatures still, a radiation type of pyrometer is available, consisting of a thermo-couple in the focus of a reflector at the rear end of the tube, which is pointed at the door or opening of the furnace.

For measuring the voltage produced by a thermo-couple, whether of base metal, platinum-rhodium, or the radiation type, high resistance millivoltmeters are available. Such millivoltmeters are produced by us in the United States, of some 1000 ohms or more. This remarkably high resistance is naturally desirable to practically eliminate the errors due to changes in the resistance of the line or wiring connecting the thermo-couples and the instrument, and also to nullify the effects of any changes in the resistance of the thermo-couples, due to heating.

Changes in resistance may be due to actual changes in length or changes in atmospheric temperature, which in turn affect the resistance of the line or wiring. We have been able to secure this exceedingly high resistance by reducing the weight of the moving element to a minimum.

The total weight of the moving element in our high resistance pyrometer, including pointer and springs is 526 mg. This extreme lightness is secured by the use of an aluminium alloy wire, which we have succeeded in enameling. The enamel coating is much thinner than the silk insulation formerly used and more turns can be secured on a coil of a given width. Likewise by the use of the aluminium wire, the weight has been reduced 66 2/3 per cent as compared with copper wire which was formerly used for these moving elements. The aluminium wire is .003 in. in diameter, and drawing this wire has been quite a mechanical problem.

The pointed tubing in this moving element is of aluminium with an inside diameter of .008 in. and an outside diameter of .012 in., or a total thickness for the wall of the tubing of .002 in. Even this weight for the pointer tubing could probably be reduced by the use of magnesium instead of aluminium, but to date we have been unable to satisfactorily draw magnesium.

I only cite these points regarding the construction of our present-day high resistance pyrometer millivoltmeter to show what development work can produce. Instruments of this type made by Siemens & Halske of Germany were never developed to this extent, at least prior to the outbreak of the war, and their moving element was several times as heavy as the one described, and in consequence the resistance of their pivoted meter was several times less. Incidentally, I think we have about reached the limit of development work along this particular line.

It will be understood that the same electrical system, such as I have described, can be used either to indicate the temperature or, combined with the proper apparatus, to record the temperature constantly on a recording sheet. There are both portable and wall type indicating pyrometers, and recording pyrometers are produced to make a record on a circular chart 8 in. in diameter, or to make a continuous record of the temperature on a roll of paper lasting two months or more. By the introduction of suitable switching mechanism a record of the temperature of quite a number of thermo-couples can be made on the same record sheet. These temperature records are distinguished by using different colors for each record line, by using numbers corresponding to each thermo-couple, or changing the form of line produced on the chart for identification.

New Heat Meter

For even greater precision in temperature measurements than is secured with the high resistance millivoltmeter, I have developed a new instrument which we call the Brown heat meter. This instrument is suitable for either temperature measurement or automatic control of temperature, and a brief description of this new instrument might be of interest.

My idea in the heat meter has been to eliminate all the bad features or draw-backs met with in using a millivoltmeter for temperature measurement. Possible sources of error in the use of a millivoltmeter in temperature measurements, even one of high resistance, consist in changes in resistance of the circuit comprising the thermo-couple and the leads or wiring, due to changes in length or atmospheric changes in temperature; also errors can occur due to temperature coefficient of the meter—that is, errors caused by atmospheric changes in temperature of the meter itself. Another source of error is a change in the actual indication of the instrument due to spring fatigue, abuse or sticking. To overcome these possible sources of error we have developed this rather interesting instrument.

Briefly, its operation is as follows: With our standard millivoltmeter of high resistance we supply an ordinary dry cell about 1⅛ in. in diameter by 2½ in. long and furnish suitable rheostats to reduce the voltage of the dry cell from approximately 1½ volts to a range

from 0 to 60 millivolts, the voltage produced as a maximum by the thermo-couples.

In our first operation we oppose the voltage developed by the thermo-couple to the reduced voltage of the dry cell, and when the pointer stands at zero it indicates that the voltage from each source is equal. We now in a second operation cut out with a switch the voltage of the thermo-couple and read the voltage of the dry-cell circuit by direct deflection. This eliminates the line resistance entirely as in a potentiometer.

We have now a deflection indicating the actual temperature developed by the thermo-couple at the moment of reading the instrument, but fluctuations in temperature of the thermo-couple will not be indicated, as we are reading the voltage from the dry cell. We have, however, incorporated other operations in this meter.

In a third operation we connect the thermo-couple to the meter instead of the dry-cell circuit and we note whether the indications are the same. By switching back and forth quickly the voltage from the thermo-couple circuit or from the dry-cell circuit can be noted. If excessive line resistance has caused the indications of the millivoltmeter to be lowered as compared with the dry-cell circuit, a rheostat is operated to bring up the indications of the thermo-couple circuit to that shown when we are reading the voltage of the dry-cell circuit.

We now leave the instrument indicating on the thermo-couple circuit; and the errors, if any, which might be due to line resistance or changes in temperature of the line have been eliminated, and we have a direct-reading millivoltmeter, indicating the correct temperature.

A rheostat is supplied in the meter of 15 ohms, which permits of adjusting the indications for a total change of line resistance equivalent to 15 ohms, or a circuit of two copper wires almost a mile long.

We have eliminated the temperature coefficient of the meter by furnishing a copper resistor in the meter equivalent to the copper or aluminium of the coil; hence, in balancing the voltage from the dry cell against that of the thermo-couple we also automatically eliminate errors due to the temperature coefficient of the meter.

There is now left only one possible source of error, the change in the actual indications of the meter due to sticking of the pointer, abuse of the instrument, spring fatigue, etc. To obviate this source of error we can supply with the instrument a standard cell with suitable resistors, and in the same manner as the meter can be tested by the potentiometer method, we can check this meter. We supply three resistors; for example, where a meter is calibrated for 60 millivolts we furnish resistors equivalent to a deflection of 20, 40 or 60 millivolts on the scale, and after balancing the standard cell against a part of the voltage of the dry cell, through these suitable resistors we can note whether the pointer swings to 20, 40 and 60 millivolts respectively on the scale. If it does not, the error can be noted and the actual error in calibration is detected.

Where the instrument is supplied with standard cell the temperature of the instrument should always be between 5 deg. C. and 40 deg. C. or 40 deg. Fahr. and 105 deg. Fahr. In fact, standa[illegible] phate or zinc sulphate will be injured if the temperature rises or falls beyond these limits. This is true of any standard cell employed in instruments

In this instrument we have all the good features of the potentiometer method of measuring temperature with the advantage that we have a direct-reading instrument which can be adjusted once every day or oftener if desired, for the actual line resistance with which it is used, and in the surrounding atmospheric conditions. The meter will then indicate correctly throughout the whole scale range, and the furnace man has the instrument to guide him without hand manipulation, and an inspector can daily check the calibration of the instrument.

Naturally, this instrument is equally as suitable for automatic temperature control as the instruments previously described when properly designed for this service.

Automatic Temperature Control

Attempts have been made in the past to electrically operate switches and valves by permitting the pointer of the pyrometer to come in contact with adjustable contact arms on each side of the pointer. Unfortunately the millivoltmeter, used with the thermo-electric pyrometer, has an exceedingly weak control for the pointer. One is easily able to blow the pointer across the scale with the breath.

In consequence, simply permitting the pointer of such a pyrometer to move into contact is not sufficiently positive to be satisfactory for automatic control work.

The automatic control pyrometer operates in the following manner: A thermo-couple formed of a nickel-chromium alloy is installed in the electric furnace, the temperature of which is being controlled. The thermo-couple actuates a high resistance millivoltmeter. Below the pointer and adjustable throughout the whole scale range is a table carrying two contact pieces, separated by a thin piece of insulating material 1/32 in. thick. The depressor arm, driven by a small electric motor or by a clock if preferred, depresses the pointer at regular intervals, usually every ten seconds, and in doing so the pointer forces together the two contact pieces below.

Let us assume the pyrometer controller is required to control the furnace at a temperature of exactly 1400 deg. Fahr. The knob on the left of the instrument is turned until the index in front of the scale stands at 1400 deg. Fahr. This index corresponds to the position of the thin insulating material which separates the high and low contact.

The switch connecting the furnace in the line is closed and the pointer slowly rises across the scale as the temperature of the furnace rises. As the switch is already closed, when the pointer is depressed on the low contact, the switch continues to remain closed, and no change occurs until the pointer passes over the neutral insulating piece and is depressed on the high contact. The switch indirectly operated by a solenoid and relay is now instantly actuated and the circuit opened. The temperature of the furnace begins to slowly fall, and when the pointer is again depressed on the low contact the circuit is again closed. This operation continues as long as the furnace is to be operated.

When the switch opens and closes the main circuit the current in consequence is either full on or off and the fluctuations are continuous within narrow limits of some 10 deg. to 20 deg. Fahr. These continuous risings and fallings of temperature can be largely reduced and closer control can be procured by the use of two rheo-

stats in the furnace line. The solenoid-operated automatic switch is then used to simply cut in and out of circuit the second rheostat.

Assuming it is desirable to continually maintain 1400 deg. Fahr in the electric furnace, irrespective of fluctuations of voltage, the two rheostats are set so that with only one rheostat in the circuit the temperature will rise to approximately 1500 deg. Fahr. With the second rheostat in the circuit the temperature drops to 1300 deg. Fahr.

When we now use the solenoid-operated switch to cut in and out the second rheostat, we naturally control the temperature only between 1500 deg. and 1300 deg. Fahr., and we do not have the rapid surges or ups and downs in temperature, and maximum control is secured.

It is realized that the same form of switch can be used to operate a valve to control a gas or oil furnace. We have found it desirable to use an automatic valve in a by-pass so as to simply control a portion of the gas or oil supply, and in the same manner as in the electric furnace control, eliminate the maximum fluctuations caused by the complete opening and closing of the switch or valve.

Assuming that we have a 2-in. supply pipe for the gas to the furnace, it is customary for us to by-pass this and use a ½-in. automatic valve, which gives us approximately 25 per cent control. This is sufficient to control the usual fluctuations in gas supply and secure very satisfactory control. This method also eliminates the difficulty which would occur where the gas is completely shut off and then turned on in full, as would occur without the by-pass control.

Temperature Signaling Pyrometer

In addition to an instrument to automatically control furnace temperatures there has been a demand for an instrument to automatically signal by lights whether the temperature is too high, correct, or too low in any particular furnace.

It has been common practice in plants in the United States, where there are a number of heat-treating furnaces, to maintain an operator at a central pyrometer, and by colored electric lights at the furnace to signal whether the temperatures are right or not. It is common practice to locate three lights above each furnace—red, white and green; the red light burns when the temperature is too low, the white light when the temperature is within certain limits, for example, 20 deg. Fahr. of the correct temperature, and the green light burns when the temperature is too high. The fireman who operates the furnace is guided entirely by the lights and a central pyrometer is used to control the temperatures.

We have been able to develop an instrument to automatically signal whether the temperature is correct or not by lights, and in this way the services of the operator at the instrument are eliminated. The same form of instrument is used for this purpose as we use to automatically control the furnace temperatures, and the pointer is depressed at intervals of every ten seconds on to contacts corresponding to the red, white and green lights.

No special battery or other source of current than an ordinary service line is required to operate these lights. The supply may be 110 or 220 volts, either A.C. or D.C. The current which lights the lamps does not flow through the instrument, but is made and broken by an auxiliary device containing the necessary mechanism. A high resistor is in series with the circuit connected with the pyrometer, which reduces the current flowing through the contactors within the instrument to less than .07 amp. This prevents sparking at the contactors and errors due to the heating effect of a current of higher amperage. The lamps may be any reasonable distance from the pyrometer; in fact, they are operative at a mile or more if desired.

The various thermo-couples in each furnace are connected successively to the instrument through switching mechanism, and at the same time a switching mechanism connects the various sets of lights at each furnace. We have constructed an instrument of this character to automatically take care of signal lights at twelve furnaces.

This form of equipment gives the fireman or operator of the furnace an indication by lights which he can easily understand, and he adjusts the valves or fires the furnaces accordingly. It is a simple method to instruct a man to keep the white lights burning and to explain what the red and green lights mean, and a less experienced workman can control the furnaces in this manner than where one is required who can read temperatures on a pyrometer scale. This newly developed instrument also eliminates the man to read the temperatures at the central pyrometer.

The extensive use of pyrometers to measure or record high temperatures will serve

(1) To eliminate guesswork as to the temperature;

(2) To reduce fuel consumption through the maintenance of the correct temperature and not excessively high temperatures;

(3) To reduce time for heating of the product due to the maintenance of the correct temperature; and

(4) To increase efficiency in operating a plant through the savings outlined above.

Instruments to automatically control the temperature, when properly constructed and applied, will eliminate entirely the personal element. The maintenance of the correct temperature in the furnace is automatic, and this is one step further, and in consequence an improvement over temperature control through pyrometers.

I do not doubt but that the next few years will see further improvements in pyrometers and temperature control. There will always be room for improvement and the co-operation of the industrial works and pyrometer manufacturers will largely hasten the development of practical instruments for the measurement and control of high temperatures.

Brown Instrument Co.,
Philadelphia, Pa.

Civil Engineers Welcomed to United Engineering Societies Building.—Fitting ceremonies marked the formal association of the American Society of Civil Engineers into the fraternity of the Founder Societies at the Engineering Societies' Building in New York on Friday, Dec. 7. An addition to the building has recently been completed for the occupancy of the Civil Engineers. The Mining, Mechanical, Electrical and Civil Engineering Societies are now all under one roof in the great Engineering Societies' Building. The library of the Civil Engineers has been added to the Engineering Societies' Library.

The Nebraska Potash Industry

By Ernest E. Thum

The western edge of the Nebraska "Sand Hills" region is now producing daily about 350 tons of salts containing 25 per cent of water-soluble K_2O, or at the rate of 32,000 tons of K_2O per annum. This shows a remarkable gain over the production of the district for the year 1916, which is included in the first item of Table I, taken from H. S. Gale's report on "Potash in 1916," a part of Mineral Resources of the United States, 1916, Part II.

TABLE I.
SUMMARY OF POTASH PRODUCED IN 1916.

Source	Water Soluble K_2O — Tons	Value
Natural salts or brines	3,994	$1,937,600
Alunite and silicate rocks, including furnace dust	1,850	715,000
Kelp	1,556	781,100
Wood ashes	412	270,000
Distillery wastes	1,845	500,900
Miscellaneous organic sources	63	38,130
	9,720	$4,242,730

The present production of potash from Nebraska is seen to be at more than three times the rate of that of the whole country during 1916, which itself was some ten times the total production of 1915. There is still a large gap to fill, however, before the normal United States consumption is attained, which amounted to about 275,000 tons annually for the four years 1910 to 1913, inclusive.

Description of Deposits

An area of about 8000 square miles of the north central portion of Nebraska is covered with a succession of low sand dunes. This region is bounded on the north by the Niobrara River and on the south by the North Platte River (Fig. 1), which rivers apparently were the barriers of the prairie and forest fires that are thought to be partly responsible for the present topography.

According to A. C. Whitford, the origin of the hills is as follows: At the close of the Glacial epoch there were one or possibly two large rivers running eastward across Nebraska which overflowed their banks periodically and produced very extensive flood plains. At the close of each periodical inundation there followed a long drought accompanied by high westerly winds. This state of affairs piled up sand dunes similar to those along Lake Michigan and caused the present topography of the sandhill region. Later, when the present climate came, the hills gradually grassed over and were possibly forested, which vegetation became the subject of Indian fires. The burning off of large tracts caused secondary shifting of the sand and to some small extent the present contour of the hills.

FIG. 1—SKETCH OF NEBRASKA SHOWING SAND HILL AREA OF POTASH-BEARING LAKES

The genesis of the sand is thought to be a feldspathic igneous rock, inasmuch as the grassy hill vegetation is much more luxuriant than that of the table lands on the borders, making an ideal cattle-grazing area.

At frequent intervals in this sand hill area are found flat-bottomed "sinks" in which the grass grows waist high, and which usually contain a shallow lake of variable extent. These wind-swept bowls form landlocked basins, collecting the surface drainage of a small area—from one to ten square miles, infrequently more.

The yearly precipitation of this region is from 15 to 18 in., while the evaporation is probably of the order of four times as much. It will thus be seen that the superficial area of any lake will be subjected to extreme fluctuation, increasing through an open winter and spring, and decreasing through the hot summer. The saline content of the waters of each lake will vary, not only from that of its neighbors, on account of its size, age and depth, but from month to month, depending upon whether the lake is full or nearly dry. Some of the lakes, whether on account of large size, youth or the possession of an underground outlet, are quite fresh. All stages of alkalinity may be observed up to absolute saturation, while the content of potash in the dissolved salts also shows extreme variation, as is shown in Table II, from analyses by the United State Geological Survey and J. H. Show of the Potash Products Company.

TABLE II.

Sample No.	Location	Per Cent Dry Salts in Sample	Per Cent K_2O in Dry Salts
1	Middle of Jesse Lake	13.55	29.97
2	Sec. 17, T. 26 N., R. 43 W.	3.21	35.85
3	Sec. 19, T. 26 N., R. 44 W. small lake	8.15	15.50
4	Large lake in same section	4.70	31.40
5	Three miles east of Reno	7.20	23.13
6	Sec. 20, T. 20 N., R. 44 W.	4.56	31.56
7	McCarthy Lake	8.83	30.62
8	Pond, ½ mile south of above	8.11	19.82
9	Richardson Lake	7.57	14.44
10	Sec. 1, T. 21 N., R. 46 W.	3.33	16.61
11	Thompson Lake	4.30	19.68
12		9.54	10.88
13		7.86	19.98
14		2.04	18.78
15		10.61	22.43
16		8.31	8.96
17		2.68	16.68
18		3.43	29.64
19		3.42	15.26
20		3.70	14.50
21		3.27	34.93
22		3.50	19.26
23		6.35	11.92
24		4.39	28.36

Table III gives a complete analysis of some of these waters, and shows that the brines carry carbonates and sulphates of the alkalis, the relative proportions being quite fortuitous.

TABLE III.
ULTIMATE ANALYSIS.

	Sample No. 15	12	16	13	23	24	20	18
K_2O	22.48	10.88	8.96	19.98	11.92	28.36	14.50	29.64
Na_2O	24.89	26.87	45.01	11.05	18.90	27.49	38.94	23.82
CO_2	11.82	2.21	29.65	2.80	22.01	20.06	28.40	15.91
HCO_3	6.29	1.39	7.91	3.40	4.98	7.56	12.13	9.20
SO_3	25.01	38.88	2.05	23.56	4.63	12.03	.44	17.30
NaCl	9.49	19.77	4.33*	39.20	37.55	3.97*	2.10*	2.73*
SO_2	....	....	2.07	....	....	.52	3.49	1.38
CONVENTIONAL COMBINATIONS								
K_2SO_4	41.63	20.12	4.46	36.98	22.10	27.07	1.03	32.80
K_2CO_3	....	....	9.41	....	....	20.83	20.39	13.73
Na_2CO_3	28.51	5.33	64.29	6.75	11.99	32.37	52.45	27.87
$NaHCO_3$	9.97	2.20	12.59	5.43	7.34	11.99	19.14	14.63
NaCl	9.49	19.77	7.18	39.20	37.55	6.55	3.46	4.58
Na_2SO_4	10.39	52.53	....	11.68	21.02	....	....	....
SO_2	....	....	2.07	....	....	.52	3.49	1.38
Tot. salts in % of water	10.61	9.54	8.31	7.86	6.35	4.39	3.70	3.43

*Cl.

The muds underlying the lakes have a corresponding variation, as is shown in Table IV. The alkali crusts

from partly or wholly dried-up basins are noted in Table V.

TABLE IV.

		Total Salts	K_2O Content in Salts
1	Jesse Lake	9.35	25.42
2	Lake near Reno	3.04	14.80
3	Lake near Lakeside	3.58	12.03
4	Sec. 1, T. 21 N., R. 46 W.	3.47	13.20
5	Robinson Lake	.17	26.37
6	Broncho Lake	.18	21.81
7	School No. 126	1.53	27.79
8	Mayer Lake	.16	18.25
9	McCarthy Lake	.55	24.02
10	Hill Lake	.89	22.49

(Analyses 1 to 4, by U. S. Geol. Sur., Bull. 540, p. 466. Others by J. H. Show.)

TABLE V.

		Total Soluble Matter	K_2O Content Insoluble
1	Jesse Lake	34.06	21.00
2	Eight miles N. W. of Lakeside	4.62	6.16
3	Three and one-half miles E. of Reno	8.51	11.27
4	Crevath Lake	34.05	17.17
5	One mile N. W. of Lakeside	30.85	2.40
6	Jesse Lake	20.25	17.39
7	Cluff	8.97	29.70
8	One and one-half miles W. of Cluff	15.12	12.76

(Analyses by U. S. Geol. Sur., Bull. 540, p. 466.)

Origin of the Lakes

Prof. Victor Ziegler, of the Colorado School of Mines, and Edwin H. Barbour, State Geologist of Nebraska, are agreed upon the main facts as to the formation of the lakes and the origin of their potash content, and their explanations are endorsed by other investigators, albeit not unanimously. Prof. Ziegler says:*

> An examination of some of the lakes shows that they are underlain by a hard pan, buff to dark brown in color, and marly in nature. This serves as a basin and prevents the loss of water by seepage into the loose sands beneath (Fig. 2). In other cases, muds, rich in organic matter, which form the bottom of the lake, are apparently impervious enough to serve at least as temporary retainers for the water.
>
> From my observations I am inclined to believe that we can recognize distinct stages in the development of these lakes depending on the general age of the scoop basins in which they occur. When a basin is first formed, the drainage after rains or as a result of melting snow is quickly taken up by the porous sands on the floor of the valley. Of necessity such drainage carries into the valley a certain amount of finer sand and such silt as may be present on the hills. This, of course, serves as a packing for the interstices of the sands on the valley floor, making them less pervious. Succeeding inflows of water are not taken up as rapidly and are held for some time before dissipation. Thus intermittent ponds and alkali flats represent youth in the growth of such a lake. As this process continues the silt carried in makes the valley floor less and less pervious and allows the water to stand for longer and longer periods. Finally the point is reached where water is held through the whole season, at least in the deeper parts of the basin. Because of their shallowness, even these ponds and lakes will show great variation in areal extent. These permanent lakes and ponds represent a mature development. Combined wind and water deposition tends to fill these basins; hence the lakes, because of continued shallowing, will again pass through a period of intermittency, representing their old age, until they finally disappear.

It is easy to see how an intermittent lake without outlet will rapidly become "brackish," and Hance, in Bulletin 540 of the United States Geological Survey, calls attention to the fact that vegetable ash, resulting either from burning or from decomposition, contains potash as a far more important constituent than soda. This is especially true of grasses. In the case of these lakes, solubles may be concentrated by surface drainage, or by the light, fine ash blown into the basins by prevailing winds. Wind concentration is thought by some to be especially important, since the waters and muds of the lake bottoms appear to average somewhat higher in potash toward their eastern edges. This is very striking in some cases, notably Jesse Lake, where the eastern half has been dammed off and all pumping done from that portion.

While the leaching of wood ashes may account for the superficial accumulation of salts, it fails to explain the local presence of more than one sheet of alkali ground water, separated by dry strata. While admitting that the origin of these waters is not yet definitely settled, some geologists who have spent much time in the area attribute the bulk of the potash content of the waters in the sands to the leaching of the considerable orthoclase feldspar contained not only in the superficial sands but in the underlying strata to a depth of several hundred feet. The decomposition products of such feldspars would form a water quite similar to the alkaline waters of this region, especially in carbonic oxide solution.

Early Work by Show and Modesitt

Mr. Edwin H. Barbour, State Geologist of Nebraska, has issued "A Preliminary Report on the Alkali Resources of Nebraska," in which he recounts the early development of the industry as follows:

> Messrs. John Show and Carl Modesitt recognized the commercial possibilities of these lakes, and to them belongs the credit of bringing the alkali industry in Nebraska to its present state. Their investigations began in 1910. In 1912 they filed mineral claims on Jesse Lake and the surrounding government lands, and erected an evaporating tower, a frame structure 32 ft. long, 24 ft. broad, and 4 ft. high. In the lower portion, gas engines, pumps a 20,000 gal. storage tank and the necessary machinery were installed. The upper half comprises a series of lattices, and some 20 floors over which the water was pumped at the rate of 300 gal. per minute. From a series of tests in November, 1912, the evaporation amounted to 1200 lb. an hour for a 10-hr day, on water containing 6 to 8 per cent total solids. The circulation continued until the concentration amounted to 10 or 12 per cent of solids. This "heavy liquor" was then transferred to an open tank and evaporated to dryness by direct heat.
>
> Since building this first simple plant many changes have taken place, and now (1915) the evaporating tower is used chiefly as a pumping and storage station. The "brine," which has a greenish yellow tint, was pumped directly from Jesse Lake through a 2½-in. pipe-line to Hoffland, a distance of three miles south, where it emptied into three steel storage tanks, one having a capacity of 10,000 gal. and two of 15,000 gal. From the tanks the "brine" flowed by gravity into concentrating vats or "cookers" each 16 ft. by 12 ft. by 5 ft. deep. When reduced to about 20 per cent solids it was pumped into steel finishing vats and brought to a 40 per cent solution.

The "cookers" were arranged in two sets, the first set of four being for preliminary concentration only. The solution is cascaded through these tanks, and heated by submerged steam coils. The crystallizing vats are also of steel, but have a false bottom of perforated steel plate. The crystals collect on this steel plate and when they build up to the level of the steam coils the latter are hoisted out, the mother liquor drained and returned to circuit, and the remaining slurry, con-

*Colorado School of Mines Quarterly. The analyses in Tables II. to V. are also from this paper.

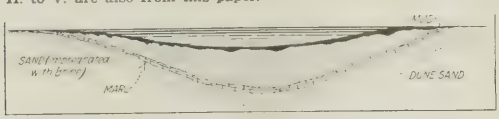

FIG. 2—JESSE LAKE, IDEAL SECTION, SHOWING GEOLOGICAL CONDITIONS

taining 30 to 40 per cent moisture, shoveled out by men in high rubber boots and loaded into box cars.

The method of producing salts from brines used by the company organized by Messrs. Show and Modesitt, "The Potash Products Company," in the latter part of 1916 is described as follows by Hoyt S. Gale in the United States Geological Survey publication on "Mineral Resources of the United States, 1916, Part II":

> The density of the brine from the pump is said to average about 9 to 10 deg. Bé. After passing to the plant through the pipe line it is heated and pumped through the solar tower in which it passes by gravity over wooden partitions, ranged one above the other like the slats of a window blind, and by this means somewhat concentrated by evaporation. It then passes to triple-effect evaporators—its density at this stage reaching about 30 deg. Bé. It then passes to a single-effect vacuum pan, where by crystallization of part of the salts its density is raised to about 48 deg. Bé. It is next passed to cooling and crystallizing vats, where, after standing a few days to permit crystallization of the salts, it is tapped off and returned to the system and the salts are shoveled out.
>
> The wet salts are dried in a rotary drum furnace, where most of the rest of the water is driven off, and are reduced to a dry, clinker-like mass carrying 27 to 28 per cent of potash salts and probably less than one per cent of moisture. The salts produced are mainly sulphates and carbonates.

This is shown by the following analysis, quoted by Mr. Gale, column 1 representing the dried residue obtained by direct evaporation of the lake water, and column 2 representing the material shipped as wet salts or slurry:

	1	2
Na_2O	21.0	17.5
K_2O	30.5	23.1
P_2O_5	0.2	0.2
Cl	1.4	1.0
SO_3	28.2	20.3
CO_2	17.3	12.9
HNO_3	0.3	2.1

The manner of handling the concentrated brine mentioned above has lately been superseded, and instead of using cooling and crystallizing vats they are boiling down the concentrated liquor in open pans, with steam coils raised 18 in. off the bottom. Crystallization is here continued until the salts reach the bottom of the coils, when they are finally dried in a rotating drum, as described later.

Pumping Plant at Jesse Lake

Inasmuch as the Potash Products Company, operating at Hoffland, eleven miles east of Alliance on the Chicago, Burlington & Quincy Railroad, was the pioneer in the field, it is natural that its organizers should pick out the best lake found in their explorations, which is called Jesse Lake, and which is probably the richest alkali lake in the whole region, having already produced several million dollars' worth of potash. After three years' operations, it is also natural that their practice in the recovery of lake waters should represent the furthest advance.

Jesse Lake is a body of water covering some 240 acres of ground, and is located about three miles north of Hoffland, in a flat, dune-surrounded basin entirely corresponding to the general description already given. At the present time (early in November, 1917), the water is only about 16 in. deep at the maximum, while high water represents a level some 6 in. higher. The pumpage, amounting to 10,000 to 11,000 gal. per 24 hours, is drawn from about 1500 wells, each sunk a distance of from 13 to 17 ft. to the top of the impervious marl layer underlying the lake bed (Fig. 2). The spacing of the wells naturally depends upon the texture of the sands—fine sands may demand holes as close as 10 ft., while the coarsest may allow an increase up to 25 ft.

The wells are drilled by hand from a small platform above the water-level in the following manner. An auger is worked down through the mud and sand until the sides of the hole start caving, when an 8-in. casing is set upright in the hole. This casing is merely a piece of gas pipe of suitable length, with the lower edge serrated with saw-teeth, 4 in. deep. Further sinking is effected by digging within the casing with a "sand bucket," working the casing down by rotating it with chain tongs. A sand bucket is merely a piece of 4-in. pipe, four or five ft. long, with a cutting point at the lower end (Fig. 3), the hole closed by a check valve. This is suspended by a bale from a piece of rope, and by means of a simple A-frame derrick is dropped through the casing, burying its cutting edge in the sand at the bottom of the hole. It is drawn up and dropped several times, and when full it is hauled out by hand and the contents dumped from the open top.

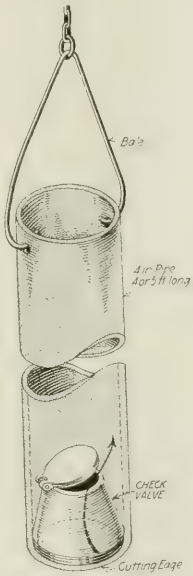

FIG. 3—SECTION OF SAND BUCKET

When the hole has reached the impervious hard-pan, a 1¼-in. "well point" is lowered to the bottom of the hole, surrounded by coarse sand, the casing withdrawn, and a new hole started. The well point is merely a piece of 1¼-in. pipe, plugged at the bottom. A short distance from the bottom the walls of the pipe are perforated (or a section of fine mesh screen set in) for entrance of the sand-free ground water. The well point is usually about 4 ft. long, the top bushed down to a ¾-in. pipe long enough to reach the surface of the lake, where it, together with forty or fifty others of like size, is connected through appropriate tees to a 2-in. pipe line leading to a pump.

There are three suction pumps mounted in small houses in the lake, collecting the brines from some 1500 wells and delivering to a fourth pump house on shore, where the entire pumpage (10,000 to 11,000 gal. per 24 hours) is forced through a 5-in. iron pipe line a distance of three miles south to the evaporating plant at Hoffland. The pumps are Deming & Gould plunger pumps, belt-connected to electric motors, ranging up to 25 hp. in size. An additional 6-in. wooden line is now under construction.

The varying grades of brine procurable from different locations in this lake are so marked that the Potash Products Company has built a dam entirely across the lake and is pumping water only from the eastern sands, replenishing surface water during the evaporating season by transferring from the larger western portion. The dam is quite a simple affair, as can

readily be imagined from the depth of water, and consists merely of two tight board fences with a little back-fill between.

Pumpage of Other Concerns

This description follows the general practice of the other operators of the district, differing, of course, in details. The Nebraska Potash Works Company, Fig. 4, with a plant at Antioch, four miles east of Hoffland, is pumping 800 tons of water per day through ten miles of 4-in. steel pipe, laid to a number of lakes in close vicinity of their works, while another company is engaged in the installation of a line of 6-in. wooden pipe leading 10½ miles southeast to Herman Lake, tapping several smaller ones en route, to furnish the Nebraska Potash Works Company with brine.

The American Potash Company, also with a plant at Antioch (Fig. 4), draws its water from a series of thirty-five lakes, largely located in a tract of land owned by John Krause some 12 to 14 miles north of the plant. This company has one wood pipe line, 6 in. in diameter and 14 miles long and one iron pipe line about 5 miles long, fed by eight pumping stations, each containing a duplicate installation of pumps with a capacity of 150 gal. per minute, driven by oil engines from 15 to 20 hp. This company pumps a large amount of surface water, and depends upon solar evaporation to a certain extent. For instance, their lake called Krause No. 1 has a very large area, 110 acres, and is but 6 in. deep. During the summer time the American company pumps water of desirable potash analysis testing only 3 deg. Bé. into this natural evaporating pan, and withdraws the same at the other end enriched to 17 deg. Bé. During the warm weather the water of this lake becomes too hot for wading, and the lake evaporated more water than the whole steam plant (1400 hp.). It seems reasonable to suppose that shallow wooden tanks with removable covers could be substituted by companies less favorably circumstanced, and enormous quantities of solar energy thus utilized. In fact, the American company intends to use solar evaporation as an auxiliary to its steam plant by building four concrete basins adjacent to their plant, each 100 ft. square and 5 ft. deep. These will be used as a combined brine storage and concentrator. In the summer time the brine will be pumped through atomizer sprays for evaporation, while in the winter nearly salt-free ice will be harvested.

The Hord Alkali Products Company, with a plant at Lakeside, 9 miles further east than Antioch (Fig. 5), is owned by men who own lands north and south of the Burlington railway to the extent of 100,000 acres. At present they are operating four pipe lines, from 4 to 8 in. in diameter and of a length up to 8 miles. All their present pumpage is from lakes to the north of their plant, but they own lakes on both sides of the railway, and eventually will be pumping a distance of 25 miles. Their operations are entirely confined to brines from sands, and they so arrange their pumpage that the water coming in averages close to a constant figure—about 5 per cent solids.

Evaporating Plant of the Nebraska Potash Works Company

At the outset it should be said that the present practice in Nebraska is merely to evaporate these alkali-bearing waters to dryness, so arranging the pumpage from various lakes that the resulting salts have as high a content of potash as possible. No effort is made to separate the soda from the potash, as the dry salts are shipped directly to fertilizer factories where it is used as such. A minimum of 14 per cent water-soluble K_2O is demanded by this trade, but the Nebraska producers have no trouble in shipping salts containing 20 to 30 per cent potash, for which they receive payment on the basis of potash content.

Consequently the potash works are merely evaporating plants, and all operate in the same manner, with minor variations in detail. Many of these variations are not the result of desire, but the necessity of taking the equipment which could be delivered in a reasonable time.

The Nebraska Potash Works Company's plants at Antioch may be taken to represent the standard evaporating practice of the field. Brief notes of their pumping plants have already been given. Mr. L. F. Hulen, president of the company, experimented on some leased lakes during the summer of 1916 by building a considerable number of solar pans of wooden floorings 12 ft. by 12 ft. by 8 in. deep. The lake water pumped into these boxes was sun-evaporated (Fig. 6), and at the end of his campaign he was enabled to ship 80 tons of cake containing 8 per cent of K_2O, which he marketed at a price of $3.50 per unit.

Following these experiments he proceeded with the

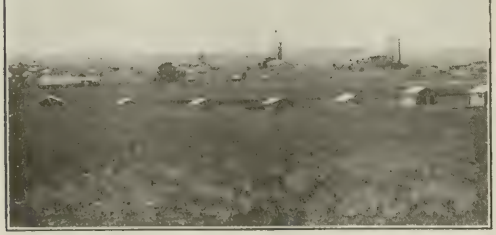

FIG. 4—PANORAMA OF ANTIOCH, NEB., FROM SOUTHEAST. RIGHT HAND, AMERICAN POTASH CO. CENTER, NEBRASKA POTASH WORKS CO.

FIG. 5—HORD ALKALI PRODUCTS CO. PLANT AT LAKESIDE, NEB.

FIG. 6—SOLAR PANS WITH POTASH CAKE

erection of the present plant of the Nebraska Potash Works Company, which evaporates some 800 tons of water per day, and which was first operated in May, 1917. The brine pumped in from the lakes is stored in two rectangular concrete reservoirs, 40 x 100 ft. and 65 x 175 ft., both 7 ft. deep. This brine is used for circulating water for condensing the steam drawn from the second effect of the evaporator, a centrifugal pump, direct-connected to an 1800-r.p.m. motor throwing 1000 gal. per minute for this service. The bulk of this warm brine is returned to the reservoir, where it is discharged and cooled by a system of sprays That part which is needed to feed the evaporators, however, is drawn through a smaller centrifugal pump similar to the condenser pump, and delivered to an Alberger heat interchanger, abstracting the heat from the exhaust from a steam engine which drives a 75-kw. generator furnishing power to pumps and other auxiliaries. From the heat interchanger the brine enters the first effect of a Swenson triple-effect evaporator. This vessel operates at an 8-in. vacuum and 208 deg. Fahr., and reduces the brine from its original specific gravity of 6 deg. Bé. to about 10 deg. Bé., when it is passed on to the second effect. This operates at 18 in. vacuum and 176 deg. Fahr., reducing the specific gravity further to 12 to 14 deg. Be., and finally into the third effect operating at 12 lb. pressure and 242 deg. Fahr. The live steam heating this vessel is here condensed and returned to the boiler as feed water. Since the liquor drawn from the third effect has a specific gravity of but 20 deg. Bé., it is then transferred to a "concentrator" or finishing pan which is merely another evaporator, acting as a single effect, and which delivers saturated brine to an 8-ft. diameter storage tank, 10 ft. high, at a concentration of from 30 to 35 deg. Bé., depending upon the composition of the salt. The evaporator and condenser room at this plant is shown in Fig. 7. This concentrator is at present blowing off large quantities of waste steam into the air, but a set of concentrating pans is now being erected for utilizing this heat, similar to the pans described in the early practice at Hoffland.

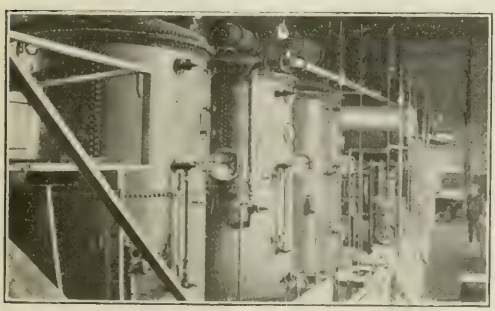

FIG. 7—SWENSON TRIPLE EFFECT EVAPORATOR, CONDENSER, AND CIRCULATING PUMPS WORKING ON ALKALI BRINE AT THE NEBRASKA POTASH WORKS CO.

The layout of the evaporating plants naturally varies considerably. At the Hord plant, where low-grade brine is evaporated, it is of course essential that the greatest care be taken to maintain their evaporating units at the highest efficiency. At this plant, where between four and five million pounds of water is evaporated daily, the owners have installed multiple-effect evaporators of four different styles—in fact, they put in any modern equipment which could be had quickly.

Drying the Saturated Brine

More variation is exhibited in the methods of drying saturated brine than in any other detail. The intermittent crystallization of the salts in steel pans has already been noted in the description of the early Hoffland practice, but this method was not only very wasteful of labor, but produced a salt containing a large percentage of water, which, of course, increased the freight charges without corresponding advantages.

Some style of rotary kiln (shaped after the fashion of the familiar cement kiln) is now almost exclusively used. These kilns are usually 42 in. in diameter and 45 ft. long, of unlined steel plate, containing numerous longitudinal angle-iron shelves riveted to their interior. The upper end of the kiln receives a stream of the concentrated brine through suitably controlled pipes, and the water is driven out as the material works its way down through the kiln. The kiln is heated by a large fuel-oil torch at the center of the lower end, which is partly stopped by a brick wall built to clear the end of the kiln. As the salts are thrown down they accumulate in small nodules, which are lifted by the angle iron shelves and repeatedly fall through the current of heated air—at the lower end actually falling through the flame itself. On reaching the lower end the nodules fall through slots in the kiln shell into a conveyor of some kind, whence they are delivered through a disintegrator to the storage bins and then sacked and loaded for shipment. The upper end of the kiln rotates within a round opening of a small dust chamber, discharging its gases through short stacks.

These kilns can produce about one ton of dried salt per hour. One difficulty with them is that the drying salt tends to stick and crust upon the inside of the kiln, requiring continuous and severe hammering to keep it loosened. In order to obviate this labor, wear and expense, the American Potash Company has replaced the angle-iron shelves by four lines of heavy chains, hung loosely at intervals. On passing the low point, these chains scrape the attached salts free and keep the interior of the kiln clean at all times.

The Nebraska Potash Works Company have devised a more efficient practice. They build a fire box at the upper end of the kiln, using an oil torch as before.

The brine is sprayed into the kiln at the same point, immediately ahead of the oil burner, through an atomizer set in the exact center of the kiln. In this way the finely divided brine is brought into immediate contact with the hottest oil flame, and drying is almost instantaneous. Only about one-third of the salt drops out the slots at the lower end of the kiln, however, and to reduce the dust losses to workable proportions, a baffled dust chamber has been built of brick some 15 feet long, 8 feet wide and 10 feet high, to receive the dust-laden gases blowing out the cool end of the kiln. A cyclone dust collector is also built into the flue before the gases finally are discharged into the air. With this arrangement practically no crushing of the salt is necessary, as it is recovered in a fine enough state to meet the demands of its fertilizer trade.

The Lakeside plant of the Hord Alkali Products Company, on the other hand, uses an original patented process consisting of a regular brick-lined cement kiln 6 feet in diameter and 50 feet long, running the temperature at a sufficient point that the product delivered at the lower end is well clinkered. This hot clinker is immediately delivered to the upper end of a small rotary cooling kiln, 3 ft. 6 in. in diameter and 25 ft. in length, placed alongside, and there sprayed with saturated brine. The heat of the clinker not only evaporates a very considerable amount of liquor, but is itself granulated by the cold liquid, the product requiring no more crushing than that of the other kilns. The output of this kiln is 150 per cent higher than those previously described.

In all cases the dust losses are considerable, as is evidenced by the billowy white smoke rolling from the kiln stacks when in operation. While a large portion of this could easily be recovered by modern treater plants, the sentiment of the managers seems to be that they would rather devote their energy to the crowding through of tons of production, rather than the saving of hundreds of pounds of waste. It is too bad that both cannot be prosecuted simultaneously, as they are both factors leading to the same object.

Canada Extends Embargo on Iron and Steel Exports.—A more complete embargo on the exportation of iron and steel products is established by a Canadian order in council of Nov. 15, published as Customs Memorandum No. 2138B. The following articles are placed under prohibition of exportation to all destinations abroad other than the United Kingdom. British possessions and protectorates: Pig iron, steel ingots, billets, blooms, bars, and slabs, iron and steel plates, iron and steel shapes (comprising beams, channels, angles, tees, and zees), iron and steel fabricated for structural work and shipbuilding.

Short Course in Ceramic Engineering.—The University of Illinois Short Course in Ceramic Engineering, will be given Jan. 7-19, 1918. The course will be under the direction of Prof. E. W. Washburn, head of the Department of Ceramic Engineering, and Mr. A. V. Bleininger, Ceramic Chemist of the National Bureau of Standards, assisted by Professors C. W. Parmelee and R. K. Hursh of Illinois, and a corps of lecturers on special topics. The two weeks' course is intended to cover in an elementary and practical manner the scientific principles underlying the practice of clayworking.

Engineers in Training

By Robert Tudor Hill

Professor of Economics and Sociology, Union College

"Liberalizing the classics" has been a favorite pastime inside and outside of educational circles. Early specialization and training in scientific and particularly engineering and other vocational technique has been much in vogue. But for some time, hastened by the war, a desire to "liberalize technical education" has been evident. An increasing number of educators and trainers, industrial and engineering leaders are sensitive to changing conditions and needs in the general business and industrial world. As a result proposals to readjust technical education are much in order.

The narrow technician is as much handicapped for best service as the broad Jack-of-all-Trades who knows a little about everything but nothing very well. This is peculiarly true for engineers who more and more must be concerned with large public problems of finance, governmental administration, policies respecting public utilities, commercial policies, transportation and so on; also industrial problems of management, production costs, labor turn-over, methods of industrial remuneration, marketing, corporation organization and finance.

Engineer's Interest in Politics

"The engineer has always been knowingly or unknowingly interested in economics but has let politics severely alone. The engineer of the future, however, must take an active interest in both subjects." This is the way in which Mr. E. W. Rice, Jr., president of the General Electric Company, before a recent meeting of engineers, began some suggestions concerning desirable changes in technical educational procedure.

New demands upon industrial leaders who are to be trained for leadership must be met by educational programs adjusted to meet needs. The suitable training and equipment of young men who later on are to have large administrative responsibilities is a matter of considerable importance. Impelling social and industrial needs require suitable modifications, changes or additions to educational practice. Of even large importance, perhaps, is the duty placed upon educational leaders and institutions to sense out changing conditions and needs and to adopt "point of view" and educational effort to these changes. But with difficulty can they do this alone; they should have the active support and co-operation of those who, in an advisory capacity, perhaps, can help them make educational programs and methods most effective. Education must be for life, and those closest in contact with it should be able to contribute richly from experience.

Most of the large engineering problems, aside from those of pure technique, center around economics. This is suggested by recent investigations of the Carnegie Institute of Teaching. Problems of management, production costs, business and industrial finance, labor and so on are those around which the wheels of industry turn. The necessity of increased emphasis upon economic studies in engineering schools and more and more effective instruction in these subjects is easily apparent.

The more light we have on the matter and from as many angles as possible the better. The results of an inquiry made among 152 engineering students in five different classes during five successive years, in Union College, are interesting and suggestive.

Choice of Vocation

The question of vocational direction is important, not only for engineers, but for all students. Table I, drawn from answers to the question, "For what vocation are you preparing?" presents at the outset a situation which, if general, is a challenge to educational leaders. Added importance comes from the fact that these students were all seniors, the majority over 21 years old, and almost all in electrical engineering.

TABLE I—VOCATIONAL CHOICE

Class	Number in Class	Decided	Undecided	*Technical Engineering	Other Fields
1914	39	24	14	33	6
1915	15	11	4	11	4
1916	33	23	10	30	2
1917	38	21	16	30	8
1918	27	17	10	22	3
Total	152	96	54	126	23
Per cent of total.		63.1	35.5	82.9	15.1

*Includes both decided and undecided vocations and indicates possibilities.

Note—In each table will be found small discrepancies due to incomplete replies. The same questions were asked each year.

These figures sustain the general impression as to vocational uncertainty secured from personal conferences with students. Young men do not follow in their fathers' footsteps, and many do not, during their years of training, plan out their own. For many, vocational plans even during vocational study are of incidental importance. Consequently vocational direction after schooling is most uncertain.

From available information concerning present vocations of eighty-seven of these same students it has been found that thirty-two are now engaged in work of their college vocational choice; eleven are now in work related somewhat directly to their college vocational choice, and seventeen are now in work altogether different from their specialized college studies and not related to their college vocational choice.

This much uncertainty and vocational indefiniteness causes much waste of time and effort of both student and instructor, apart from financial losses. Later on the man, personally, loses from whatever inefficiency this entails and business and industry pay the price. Expensive labor turn-over begins back in the colleges and secondary schools.

Some kind of suitable vocational guidance, advice and direction is desirable. Definite life purposes are more needed among college and technical men. It is reasonable to expect technical students, at least, to know what their training is for. The value of their training, then, would be greatly enhanced and weaker students of vocational uncertainty would be eliminated or directed into more suitable vocations in accordance with interest and capacity.

Slight Interest in Management and Business

Answers to the question "In what phase of engineering are you most interested?", tabulated in Table II, suggest something of the wasted time of young men in technical training, at least during ordinary times, as well as the uncertainty of vocational choice upon graduation. But a more important problem is involved. Technical students are expected to be interested chiefly in the technical aspects of their work. But newer demands of business and industry on the non-technical end of things should be brought to the attention of technical students. In some way they should learn of the quickened demand for able administrative and executive work in engineering and industry, and should be given an opportunity to prepare for such service. War conditions show up a peculiar national weakness which far-sighted leaders have realized for some time. Most emphasis in the business and industrial world has been placed upon machinery and materials. Important as these are, changing conditions and needs increasingly emphasize the human factor in industry. Management of men is as important as the design of machinery. Industry is rapidly moving into a new period of "human technique." The signs of the times are unmistakable.

TABLE II—ENGINEERING INTERESTS

Class	Number in Class	Technical	Management and Business	Uncertain
1914	39	32	4	3
1915	15	12	1	1
1916	33	26	4	3
1917	38	29	8	1
1918	27	15	2	10
Total	152	109	19	18
Per cent of total.		71.7	12.5	11.8

For best service in this field men must be as carefully trained as for more limited technical work. A new kind of training must be added to the old. New points of view must be given to the younger men, and new visions of large industrial service. While in training young men should have the opportunity to put in broad foundations for future service in both technical and non-technical administrative fields. Technical training may well be "humanized" and a large infusion of general training added, particularly in economics, government administration, history and philosophy.

The lack of information among college and technical school students, and even graduates, concerning vitally important industrial, social and political problems is striking. To immaturity is frequently added lack of interest, but this is due largely to lack of opportunity or incentive. In any case, the situation is unfortunate and ought to be remedied. A "social consciousness" is more and more needed among men of responsibility and affairs. It should be developed purposely among men trained for largest service.

Dearth of Study and Reading in Economics

The question, "What kind of economic reading, if any, have you done previous to this year?" appears to have been answered frankly. The result is given in Table III.

TABLE III—READING AND STUDY

Class	Number in Class	Previous Study*	Some Reading	Little Reading	No Reading
1914	39	1	3	8	20
1915	15	1	2	1	11
1916	33	3	3	8	19
1917	38	3	8	2	24
1916	27	2	1	4	20
Total	152	10	17	23	94
Per cent of total.		6.5	11.2	15.1	61.2

*In High School or College.

Is this a typical state of affairs among American college men to-day? If so, can it be corrected? Or are men in technical training particularly limited in their reading and thinking? There is much unconscious absorption of ideas touching the important problems of labor, industrial organization, finance, agriculture, business management, investments, markets, the social unrest, Socialism, and so on but little definite and directed thinking. Immediately upon graduation most

college men are projected headlong into the midst of an industrial, business and social system which is of utmost consequence to them. But more than 90 per cent of the boys of the country never go beyond the second year of high school, where the lack of suitable civic, vocational, social and industrial training is notorious. Thus the vast majority of men are deprived of a training during youth and early manhood which has most direct, practical value besides a civic utility.

It is unfortunate that special encouragement and assistance for such life needs should be deferred until the upper-class college years. It is doubly unfortunate when a technical school, for instance, provides no opportunity at all for study and training in political science, economics, administration and government. Some technical school curricula can be severely criticized for such omissions, and altogether too many young engineers, chemists, physicists and other technical workers are thrown into an industrial world whose character, history, organization, purposes and problems are not even appreciated, much less understood.

Nevertheless, students to-day are much more sensitive to many questions of interest and importance outside specialized technical fields than they realize. And the nearer schools are brought into contact with real life and actual conditions and needs, the more vitally will such interests be quickened. The selection by these 152 students of economic topics of special interest, irrespective of information concerning them, is suggestive. The items are given in Table IV.

TABLE IV—SELECTED ECONOMIC TOPICS OF INTEREST

Class	Number in Class	Industrial Organization and Management	Labor Problems	Finance	Social Problems	Public Questions	Domestic and Personal Problems	Business
1914	39	3	13	4	5	23	11	5
1915	15	3	13	5	3	4	2	3
1916	33	..	17	3	3	12	3	3
1917	38	4	15	6	1	10	3	4
1918	27	4	14	8	4	5	2	6
Totals	152	16	72	26	17	54	20	18
P.c. totals	*	7.2	32.3	11.7	7.6	24.2	9.0	8.0

*Replies received numbered 223. Percentages are computed on this base.

The importance attached to these several topics by technical students is both interesting and instructive. The selection, in fact, is a challenge to business men, industrial leaders and to those engaged in active political life; it is doubly so to the teacher who seeks to make education a vital force for national efficiency.

Technical Courses Heavily Loaded

Technical curricula and courses generally are so loaded with desirable and apparently necessary technical studies that, with time available, much liberty in choice of subjects within or outside the courses themselves, has seemed impossible. Unfortunately, however, such limitations narrow the training seriously. Men are turned out as fairly good mathematicians, electricians, engineers, helpers, instrument men, chemists, designers, draftsmen, and so on, but for largest service in positions of modest executive responsibility they are materially handicapped. Some students feel this state of affairs when they are finishing their technical studies, and if not too much warped would be glad to "broaden out" if possible. Generally, however, this feeling comes on some time after graduation, when actual experience outside the classroom and laboratory makes them more appreciative of the non-technical problems of their chosen vocation.

It is possible that from a sense of politeness or consideration the factor of error should be applied to a study of answers secured from the question: "Would you have elected economics if optional?" (Irrespective of the instructor.) Four per cent of the students did not venture an answer. Seventy per cent voted yes, 13.8 per cent, no, and 11.8 per cent were uncertain. About half othem thought that probably they could "uick up" something useful or interesting in the course of study—a one-semester course; about one-fourth of the students had special interests upon which they wanted more information; about one-fifth had no particular reasons, either general or specific, why they should carry the course; the others had no answer at all to the question: "What do you hope to gain from this study?" These might be represented by the fellow who said: "A passing grade."

Conclusions

Some tentative conclusions may be drawn from this modest study and from a few observations made elsewhere.

1. Increasingly important problems in the fields of industry, business and public service are economic in nature. Efficient service in any field requires suitable training. Most emphasis must be placed upon economic study for such service.

2. Engineering and technical education is peculiarly suitable for business and industrial leadership. But such training must be more than technical.

3. Non-technical training, however, must fit in with real conditions and needs. It should also be adopted to the peculiar needs of technical students.

4. To broaden out technical courses some technical work will be modified or discarded; or, such courses must be lengthened at either or both ends.

5. Readjustments in preparatory and earlier secondary-school training are desirable so that preliminary training may be completed earlier. This will save time below and gain time above.

6. Suitable vocational advice, guidance and direction, may be introduced to save time and avoid waste effort.

7. Limited "point of view" must not be sacrificed to "breadth of view" at the behest of immediate technical demands. Technical as well as so-called cultural education must be for life and service.

8. Non-technical instruction for technical students must be as efficient as technical instruction. Teachers through their own training and experience must be able to relate their non-technical teaching to definitely discovered conditions and needs of the technical world itself.

Schenectady, N. Y.

The solubility of **pure radium sulphate** in water in different concentrations of sulphuric acid and in sodium sulphate solution has been determined by the United States Bureau of Mines in connection with its technologic investigations on carnotite ore. This work has a definite commercial application, giving important information on the best conditions for precipitating the radium from solution.

Utilization of Manganese Ores in Sweden*

By Joh. Harden.

The importance of manganese in the steel industry is so well known that it would be idle to enter upon its merits in that respect and may be considered to be outside of the scope of this paper. It is sufficient to repeat a well-known Sheffield expression, saying: "Manganese is about the best tonic for a poor steel." Of course, it is to be borne in mind that for some purposes manganese must be avoided; nevertheless, the expression holds good in many cases.

Sir Robert Hatfield in Sheffield has no doubt expanded our knowledge on this subject more than anybody else, especially as regards its physical influence upon steel. The enormous number of tests carried out under his direction are far too many to be referred to here. They are recorded in the Proceedings of the Iron and Steel Institute, METALLURGICAL AND CHEMICAL ENGINEERING, and elsewhere, and may be available for those interested.

Our main question is: Can we supply our own need of this useful agent from our own sources? Also, in what way is the metal to be handled to obtain the best economy possible?

Looking over the records of a *normal* year of consumption, such as 1913, the import to Sweden was, according to the Government reports, during the year around 5000 tons ferromanganese and spiegeliron, at a commercial value of 961,516 Swedish crown (about £48,000, or $232,800), while the home consumption during the year 1916 was about 5500 tons, equal to around 4000 tons pure manganese, besides silicomanganese corresponding to about 2000 tons pure manganese.

During the year 1915, according to the same reports, the country produced 7607 tons manganese ore, valued nominally to 320,760 Swedish crowns (about £16,000, or $77,600). The present requirement of the country, for home use only, is about 4000 tons manganese, of which one-half may be in the form of silicomanganese.

As to the ore fields, only three seem to be of any importance at present, viz., the Spexeryd district, carrying an ore of about 45 per cent Mn.; the Longban district, with an ore of some 34 per cent Mn. (as well as some tailings and concentrates, with about 28 per cent ore, some of which is used for the manufacture of colored glass bottles), and, finally, the Bolet and Dalsland district, which although being worked has not so far come into prominence. The same may be said of several smaller fields distributed over the country but of less importance, as most of them contain chiefly iron ore high in manganese.

Of these districts, the Spexeryd is the most advanced; yielding, without spoiling the streaks, at least 6000 to 7000 tons of ore per annum, if required.

If at present about 2000 tons ferromanganese and, say, 3500 to 4000 tons silicomanganese are being produced in the country, these factories are so equipped that they can increase their capacity to at least 8000 tons per annum.

One of the factories, the Vargön Co., possesses a power capacity of some 15,000 hp., and the other, the Ferroalloy Co. at Trollhättan, has some 3000 hp. These power capacities are of course not at present used for the production of manganese only, but various other alloys and materials, but may in course of demand be made available for the increase; hence the possibility exists to provide the country with its requirement of these materials from independent sources.

As to export to other countries, the lack of tonnage is of course a serious objection. Besides, the rich deposits of Mysore and Bangalore as well as those of the United States, and the low coal prices in England and the United States may prevent any extensive export. At present a total export prohibition to any foreign country is strictly levied by the government so as to secure the home demand.

Methods of Smelting

For the production of ferromanganese the ores pyrolusite, MnO_2, and manganese spar, $MnCO_3$, are the chief materials. Pyrolusite has theoretically up to 63 per cent of Mn, and the spar 61.72 per cent MnO. Other ores, such as braunite, Mn_2O_3, hausmannite, Mn_3O_4, psilomelane, MnO_2, and rhodonite, $MnSiO_3$, are used with advantage. In some cases even manganese-rich slags are being used.

Before the introduction of electric furnaces on a larger scale, it was practice to smelt the manganese ore together with charcoal and iron ore in blast furnaces. In this manner spiegeliron was obtained, containing from 5 to 20 per cent Mn. Even at present a considerable quantity of high-percentage ferromanganese is being produced in the blast furnace, especially in England and America. The loss of manganese, however, is very high owing to the fact that the metal and its compounds are very volatile at high temperatures and a great deal is carried away mechanically by the blast, also a good deal of re-oxidation is unavoidable.

It is on account of these facts that the electric smelting method has been widely adopted and may under otherwise suitable conditions supersede the old method. This holds true especially in such countries as Sweden, where the supply of ore is rather limited and charcoal is becoming more and more expensive every year; wherefor the greatest economy with both is called for. The cost of power is, on the other hand, comparatively low, since power may be had for something like £2 ($9.70) per hp.-yr. or less, when taken in bulk, and this feature alone would almost be sufficient for a decision in favor of the electric furnace.

In addition to this stands the fact that the material produced in the blast furnace has always a very high carbon percentage, as a rule from 8 to 12 per cent, and a higher carbon content always calls for a lower price on the market. It is true that a lower percentage of carbon also may be produced by careful handling in the shaft furnace, but in that case the losses are prohibitive, while in the electric furnace a product with lower carbon can be made at will without any excessive loss of material.

In practice also, a considerable quantity of manganese alloys other than ferro are in demand, and these are hardly to be produced economically, if at all, except in the electric furnace.

Furnace Types

As to furnaces, either single-phase furnaces with conductive hearth or three-phase furnaces with or without the neutral point at the bottom may be equally ad-

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vantageously used. When working on a large scale, the latter type, with the neutral point under the hearth, seems, however, to be mostly preferred for many reasons. The electrodes become smaller, the heat-distribution in the furnace is more uniform and the power regulation more even; also the tapping is less troublesome.

It is fortunate that ferromanganese has a comparably low smelting point, from 1250 to 1375° C. (depending on the grade), wherefore it may, contrary to ferrotungsten, for example, be easily drawn off into molds, and is hence more easily broken up.

The furnace is charged with the proper mixture of ore, coal and flux at regular intervals; iron in suitable proportions is added as the ore requires. The iron should be added as *scrap* and not, as was formerly the practice, as ore, since the reduction of the iron ore is consuming a good deal of power and may be more cheaply produced in the coke-furnace; besides, the iron ore is apt to upset the run of the furnace and is therefore more uneconomical. Finally, the separation of the manganese from the slag takes place much more readily if the iron is added in the metallic state than if ore is added; hence a greater saving in material.

Lime, quartz, etc., also are to be added as the individual ores require to insure good working.

The consumption of power is dependent on the following three factors, namely: The size of the furnace, the proper handling of the charge and operations, and, finally, on the desired percentage of carbon and silicon.

As a basis for estimation, however, we may assume that a furnace with a capacity of, say, 3000 kw., three-phase, properly managed, should not consume more than 8000 to 8500 kw.-hr. per ton ferromanganese under normal conditions.

The furnace should be worked so that *no open arc* will occur. If this is not avoided great losses and a higher power consumption per ton will result. The charge must be kept so high in the furnace that the actual working zone is fully covered and the incandescent part of the electrodes nearly buried. The tappings must be timed with great care, and overheating of the metal must be studiously avoided. Any mistake in these directions will unavoidably result in bad economy.

The manganese easily forms double carbides of Mn-Fe and C. The manganese carbide proper, CMn_3, holds theoretically 6.77 per cent C and 93.23 per cent Mn. Ferromanganese, as produced in the electric furnace, will as a rule hold about 6 to 8 or 10.5 per cent carbon, depending on the manner of working. A typical analysis of the market product is:

	Per Cent
Mn	80.60
Fe	11.93
C	6.41
Si	0.65
P	0.08
S	0.026

A low content of silicon is always desirable. A much lower percentage than the one given above, down to 2 per cent and even under 1 per cent, *can* be obtained with adequate working of the furnace. Should such a low carbon be called for, it will as a rule be found much too uneconomical to produce it in one operation, but far better to refine the product in a subsequent treatment. This operation is a rather difficult one and of course necessitates a larger power expenditure; hence the higher price for such material.

In the case of silicomanganese a suitable quantity of quartz is added to the charge, reckoning with the amount of silicon which is usually volatilized as well. The finished product holds generally about 70 per cent Mn, 18 to 20 per cent Si and 6 per cent C.

A few special steels require an alloy particularly high in manganese, up to 98 or 99 per cent. Such material usually is produced by the thermit process, where finely divided aluminium is used as a reducer. In this way an alloy very high in manganese and low in carbon is obtained, but the product is also very expensive, on account of the high price of the aluminium. Also, although the method is very simple, it cannot be used on a large scale, as is obvious.

It is also possible to produce pure manganese by means of electrolysis of the molten oxide in a fluorspar bath. According to G. Gin in France, only 3475 kw.-hr. per ton manganese would be required.

All such methods, however, have only a curiosity value compared with thermic smelting and probably will never be used earnestly on account of low production figure and high cost of plant.

Methods of Using the Alloy

There is no doubt that up to recent times several mistakes were made when the alloy was to be added to molten open-hearth or Bessemer steel, especially when material high in manganese was to be made. If added direct in the Bessemer converter, the primary effect of deoxidation is certainly obtained, but during the subsequent finish blowing most of the free manganese will burn away or get lost, and the desired content in the steel will be very problematical.

If added direct in the open-hearth furnace, an uncertain quantity will at once enter the slag, and in each case an unavoidable loss of manganese will result.

When this was recognized, the practice changed to the addition of the alloy in a crushed state, preheated sometimes, but still solid, into the ladle just after pouring. That method is still very much in use.

The consequence of this practice is, as a rule, that the ferromanganese will not, in spite of rigorous stirring, mix and *alloy* properly to its whole content with the liquid mass of steel in the ladle, but single particles will remain partly in a semi-fused state, whirling round in the mass, leaving behind a trail much like a comet's tail of manganese.

If such an ingot is cut in two lengthwise after it has cooled, it will be observed that these lumps form light spots, more or less prominent, as hard lenses in the steel. If the ingot is rolled out, these lenses elongate forming the well-known "ghost-lines," so called since they sometimes disappear and again turn up elsewhere.

Such ghost lines are, as so often recognized, very detrimental to the steel, especially for the milling or drilling. They are much harder than the surrounding part, which will cause the milling tool to make a deviation from the true cut, or else will ruin the edge of the tool in a short time. It has occurred more than once that a large delivery of otherwise excellent ware had to be rejected in bulk, and analysis of the spots has invariably shown that inferior alloying was the cause. Such occurrences are not apt to add to the credit of the firm

apart from the economical losses in the direct way; in fact, it has recently brought about a costly lawsuit, in which the maker lost the case, as a matter of course.

The only correct way to avoid any such result is, therefore, to add the ferro in a *liquid state* at the *right moment* direct into the liquid steel in the ladle and stir properly. This, of course, does not pertain to crucible steel, where the alloying takes place under entirely different conditions.

The above fact was also clearly recognized in time by the more advanced steel makers, although the old method is still used in places. The question then arose, how to proceed to add the alloy in the molten state in the best way.

Superiority of Electric Furnace

The electric furnace was then adopted as being considered the best melting device for that purpose. For instance, at Messrs. Roechling works, where the author had several opportunities to follow the process closely as to economy and utility, the pig iron was drawn direct from the blast furnace and taken direct into the Bessemer converter, where it was blown down in about seven minutes. It was then tapped into a ladle, the right amount of ferromanganese, previously melted in a suitable electric furnace, was added, and a part of the charge was brought into an induction furnace and finished off as high-grade steel, while another part was treated elsewhere into a lower grade of steel for rails, etc.

As this procedure was repeated as often as every other hour and about 120 to 140 lb. of ferro was added each time, it was necessary to provide for a suitable stock furnace for molten ferro only, which was always ready to deliver the adequate quantity of metal required.

A furnace specially suited for this purpose must be so designed that a very even supply of heat is provided, without the danger of accidental overheating or breakdown, which would lead to loss of material and disturbance of the whole series of subsequent operations. Oil furnaces have been used for the purpose with success, but, in Scandinavia especially, their demand on oil cannot be met, for obvious reasons. Besides, the oil furnace requires wind, and in excess, too, in order to obtain the temperature required, which will lead to oxidation of a part of the metal.

The electric furnace is, therefore, especially in the countries mentioned, the most appropriate heating device, particularly if worked with indirect arc, or better still as induction furnace. The latter type is doubtless more economical as far as heat-efficiency goes, although the lining question may be more difficult to handle, inasmuch as the manganese, as is well known, possesses special cutting properties on linings. This difficulty can be satisfactorily solved, however, by the choice of right material and proper handling.

Messrs. Roechling were using either a normal three-phase induction furnace or else a resistance furnace of a special design, which gave very good results, particularly the first mentioned. At another works a furnace with submerged arcs, somewhat similar to the Hèroult furnace, but with three carbons (the Nathusius type), was used in another instance to be related here, which also worked satisfactorily.

Some of the figures given herewith are taken from *Stahl und Eisen* and others are the author's own observations on the spot.

The furnaces in question had a capacity of 3 tons and 1½ tons respectively, which in the former case was too large, but, as the result shows, the efficiency did not suffer much on that account.

The power capacity was about 300 kw. when melting and 120 kw. for maintaining the heat after liquifying.

Heat Balance and Thermal Efficiency

In order to obtain reliable figures of the heat balance, the actual or specific heat of ferromanganese was first determined. For this purpose, a material containing 80.6 per cent Mn, 11.93 per cent Fe and 6.41 per cent C was very carefully melted and exact readings taken under proper conditions. The results of these observations are given in Tables I and III.

TABLE I—SPECIFIC HEAT OF FE-MN

Temperature C°	Average Spec. Heat	Calories Represented by 1 Gr. Fe-Mn
600	0.1625	97.5
700	0.1667	116.7
800	0.1711	136.8
900	0.1763	158.6
1000	0.1822	182.2
1060	0.1863	197.4
1200	0.2133	255.9
1258	0.2225	280.0
1340	0.2268	304.0

TABLE II—HEAT-BALANCE PER TON FE-MN

Heat Supplied	Kw.-hr.	Per Cent	Heat Expenditure	Kw.-hr.	Per Cent
Electric energy supplied	833	100	Remelting heat	354.0	42.5
			Melting of the slag	7.4	0.9
			Losses		
			Transformer	33.3	4.0
			Leads	58.3	7.0
			Cooling water	50.0	6.0
			Radiation and conversion losses	330.0	39.6
	833	100		833	100

From the tables it will be seen that the thermal efficiency was only 43.4 of the heat supplied. This is probably to be accounted for by the fact that the furnace was too big (3 tons) for the charge and also that the time between rechargings was rather long.

This balance refers to the arc furnace. The corresponding figure for the induction furnace with a capacity of 700 to 750 kg. was 63.2 per cent, the conditions in that case being more favorable generally, as the charging could be done quicker and the heat insulation could be more effective. Also the losses in the leads, which are a heavy item, were eliminated. The charge was in both cases kept at a temperature of about 1350° C., which is somewhat too high, but was necessary on account of the distance over which the metal must be carried.

Should a furnace be erected solely for this purpose, there is no doubt that it could be arranged so as to work with greatest economy, if all other uses were to be excluded.

Cost of Operation

The cost of operating the arc furnace for ferromanganese is given as follows. (The power cost was in round figures 0.02 of a shilling per kw.-hr.)

Cost Per Ton Fe-Mn	Shillings	Dollars
Power: 833 kw.-hr. @ 0.02 sh.	16.66	4.00
Electrodes @ 35 sh. per 100 kg.	1.90	.47
Labor costs	1.65	.40
Linings and repairs	0.65	.15
	20.86	5.01

Or, in round figures, £1 10d ($5) per ton ferromanganese.

This does not include the heat for the preliminary heating-up; while this by continuous working would throw the balance out of proportions, of course a small amount should always be added on this account, depending on the length of the campaign.

The corresponding figures for the induction or resistance furnace show about the same result, or a little lower, namely 19s. 3d. ($4.68) per ton. As the electrode item is eliminated the costs should be less, but the maintenance of the lining costs a little more, hence the smaller difference in the sum total.

The heating-up of the arc furnace after shut-downs and repairs costs as follows:

	Shillings
Power: 630 kw.-hr. @ 0.02 sh.	12.60
Coke and electrodes	5.50
Labor	2.10
	20.20

Or just over £1 ($4.85).

The heating up of the induction furnace cost 17s. 6d. ($4.20).

The loss of manganese was in both cases very slight, or 0.385 per cent in the electrode and 0.360 per cent in the induction furnace, consequently of no practical account and need not be considered.

Comparative tests were also made to ascertain the advantage between the addition of molten ferromanganese and such added in solid, but pre-heated in oven.

The result was as follows:

	Molten Ferro-Manganese				Solid Preheated Fe-Mn				
	Ingot Weight,	Actual Mn Used		Calculated Mn	Ingot Weight,	Mn Used		Saving in Mn Added Liquid,
Date	Kg.	Kg.	%	Kg. %	Kg.	Kg.	%	%
31/1	19,160	120	0.61	129 0.67	498,860	4,980	1.00	33
1/2	86,990	350	0.40	522 0.60	341,510	3,700	1.08	44
3/2	67,330	280	0.42	355 0.53	397,590	4,220	1.06	50
4/2	62,290	290	0.46	347 0.55	343,270	3,710	1.08	51

Average saving: 44.3%

If the ferromanganese is taken at the old price per ton, 204s. ($49) per short ton, the costs and savings work out as follows:

	Shillings	Dollars
Fe-Mn added solid	31,221.82	7,493
Fe-Mn added liquid	24,471.41	5,873
Sum total saved	6,750.41	1,620

Or, in other words, by producing 19,827 tons ingots, a saving of £337 1s. 6d., or, in round figures, 4½d. ($0.09) per ton ingot.

This shows that an actual saving in material is the direct result of liquid addition, a fact which speaks for itself when large quantities are to be handled, especially now, as the price of ferromanganese is nearly five times higher than normal. A good brand, with a carbon of 5.5 per cent and low in silicon, is now costing even up to £75 ($365) per ton, while silicomanganese costs about £45 ($220) per ton, which should tell very markedly if a saving of something like 44 per cent is made when added liquid.

In addition to this comes the fact of superior finished material, free from "ghost lines" and hard lenses. If this is rightly taken into account a secondary saving of great importance is made as well, which is not to be neglected since a rejected delivery may cost the works more than the value of the entire material in question.

Finally, the time-saving element should not be overlooked; if ready liquid alloy is really at hand, it is obvious that the finishing off of a charge goes much more rapidly and surely than if solid stuff is to be added, and this is of no mean importance to the total efficiency of the plant.

Taken in all, it seems as if the electric furnace has one of its largest fields in this direction at present, as no other melting device is so adaptable to this task and the immediate result is sure and certain. Of course, the prejudice of works managers and workmen alike must first be overcome, and, we fear, this is the most difficult side of it. It is much easier to design a serviceable furnace than to persuade folk to use it and to handle it properly.

Stockholm, September, 1917.

Some Notes on Fusion Apparatus

By Frederick Pope

Fusions involve widely differing apparatus, varying from the ordinary cast-iron, hemispherical kettle shown in Fig. 1 to the cast-steel autoclave as shown in Fig. 2, or to the wrought-iron steam-jacketed vessel as shown in Fig. 3.

Perhaps the most common type of kettle used for alkaline fusions is that shown in Fig. 1. This kettle has numerous modifications. It is made approximately hemispherical, as shown in Fig. 1, with a curving bottom and sloping sides, as shown in Fig. 6, or the deep form, as shown in Fig. 4.

In kettles of this class the cone type of agitator is seldom if ever used. The propeller type of agitator is used rarely, and, when used, for special work. The agitator is usually some modification of the horseshoe type, either a plain horseshoe or a horseshoe with the blades deflected to give vertical as well as horizontal impetus, as shown in Figs. 1 and 7; or it may be provided with a number of blades working against break-

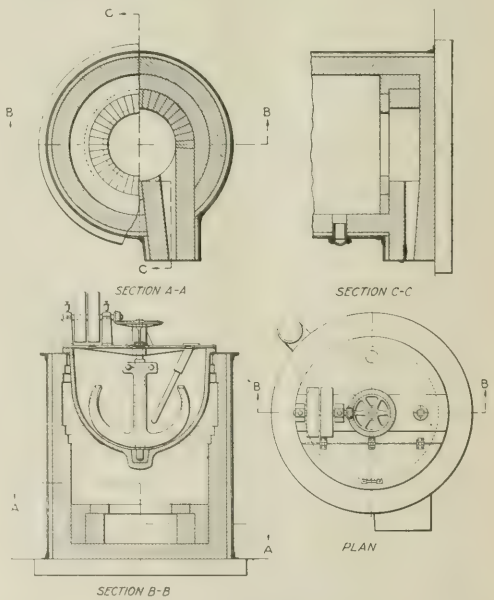


FIG. 1—A COMMON TYPE OF KETTLE USED FOR ALKALINE FUSIONS

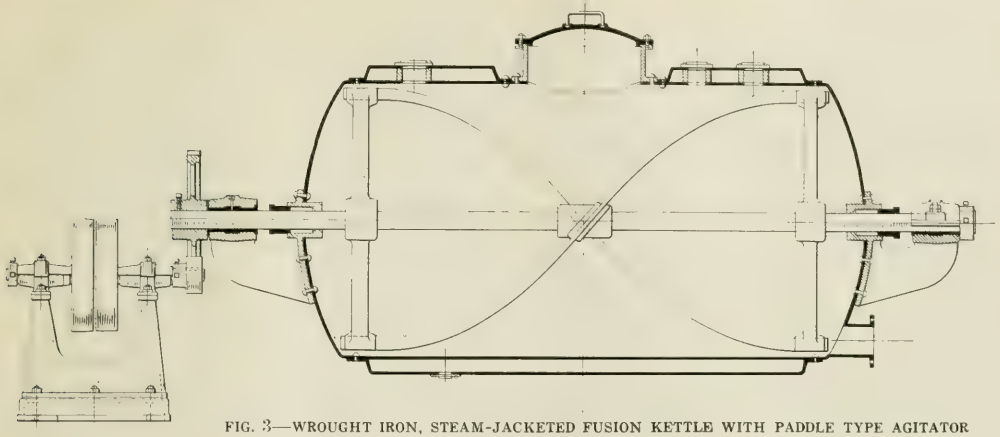


FIG. 3—WROUGHT IRON, STEAM-JACKETED FUSION KETTLE WITH PADDLE TYPE AGITATOR PROVIDED WITH SPIRAL FLOATS

ers, as shown in Fig. 4. This type of agitator is also used without breakers. Other modifications are the sloping shaft, as shown in Fig. 5, or off-center, as shown in Fig. 6. Either of these last two designs gives excellent agitation, the sloping type particularly so.

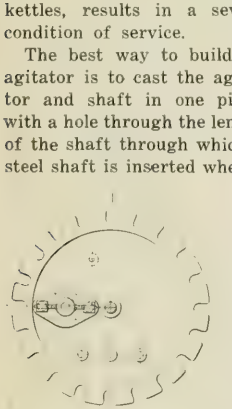
There is a variety of methods of construction for these agitators. There is one form of construction which consists in cutting the agitator from a piece of boiler plate and clamping it to the end of the shaft. This is sufficient for some purposes, but for most purposes it is not good construction. An improvement on this is to bolt the blades to a cast-iron hub, which is fastened to the shaft, and while this is sufficient for some purposes it is entirely unsuitable for others.

A further advance is to cast the agitator in two parts, bolting them together on a square shaft, as shown in Fig. 7. This method of construction has been extensively used.

The objection to all of these methods is that it is difficult, if not impossible, to keep the bolts tight. The contents of the kettle often have an action on the metal. This, coupled with the high temperatures used in the kettles, results in a severe condition of service.

The best way to build an agitator is to cast the agitator and shaft in one piece, with a hole through the length of the shaft through which a steel shaft is inserted when a bottom bearing is used. When a bottom bearing is not used the hole extends partly into the shaft, the stirring device being made fast with a key and clamp bolts, as shown in Fig. 6. When a bottom bearing is used, the construction shown in Fig. 1 is advisable, the bottom bearing being a removable plug, as shown. By following this construction the bottom bearing is easily repaired. No attempt is made that the plug shall be a nice fit in the kettle. However, it is made tapering.

Agitators for autoclaves must be very strongly built. In high-pressure autoclaves they are cast steel, keyed and pinned to a soft-steel shaft. The agitating shaft in an autoclave must be of ample size to take care of its load with an ample factor of safety, but at the same time it should be kept as small as possible, since with an autoclave working at a pressure of 1000 lb. per square inch, carrying a 2½-in. shaft, there is an unbalanced



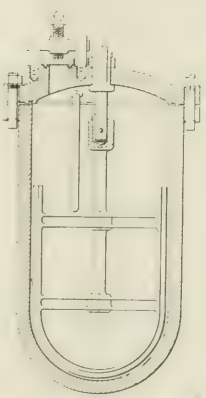


FIG. 2—A CAST STEEL AUTOCLAVE EQUIPPED WITH GATE TYPE AGITATION

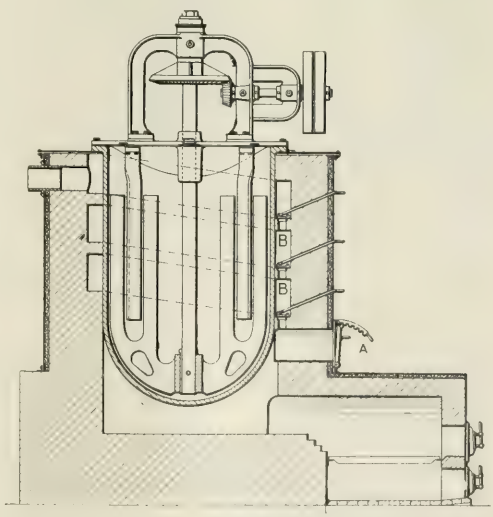


FIG. 4—DEEP FORM OF FUSION KETTLE IN A DUTCH OVEN SETTING

force of over 7800 lb. tending to drive the shaft out of the autoclave.

Conditions calling for the propeller type of agitator in an autoclave are rare, although in many instances an off-center agitator of the gate or horseshoe type is used to advantage. Autoclave agitators are often of the scraper type, as shown in Fig. 8, frequently supplied with floats inclined in one direction on one side, and in the opposite direction on the other, so that the contents of the autoclave are first lifted and then depressed.

In the wrought-iron, steam-jacketed type of fusion kettle the agitator can be either the ordinary paddle type, or paddle type with spiral floats, as shown in Fig. 3.

In the case of a vertical steel autoclave, working at comparatively low pressures, the agitator may be of any of the standard types—propeller, gate, or horseshoe—as the conditions of service indicate. In designing an autoclave of this type the propeller with the shaft inclined to the vertical should be carefully considered. The merits of this type of agitation are too seldom recognized.

A fusion kettle may be discharged from the top or the bottom. When it is discharged from the bottom by gravity there must be a bottom opening. A bottom-discharge kettle is impossible in such a setting as shown in Fig. 1. It is difficult to devise a satisfactory bottom-discharge kettle when it is fired with oil or coal, unless a Dutch oven or similar setting is used. The discharge pipe must be carefully protected with clay sleeves, or otherwise, to prevent local overheating, it being borne in mind that there is no circulation in the discharge pipe.

When bottom discharge is used, the best plan is to set the kettle without protection for the discharge pipe, but so arranging the heating that no flame, or only a soft flame, reaches the bottom of the kettle. An arrangement of this sort is shown in Figs. 4 and 6.

The system of burning producer gas, known as "flameless combustion," which is extensively used in England, is excellent for a fusion kettle with bottom discharge. In this case no protection of the discharge pipe is necessary.

Fig. 6 shows a system of combustion using gas coming into use in this country, which is also excellently adapted for fusion kettles with a bottom discharge.

In considering a bottom discharge it must be borne in mind that when caustic soda or caustic potash is used in fusions that if the discharge pipe is allowed to cool below the freezing point of these substances—which is 318 deg. in the case of sodium hydroxide, and 360 deg. in the case of potassium hydroxide—that it will be impossible to discharge the kettle without first

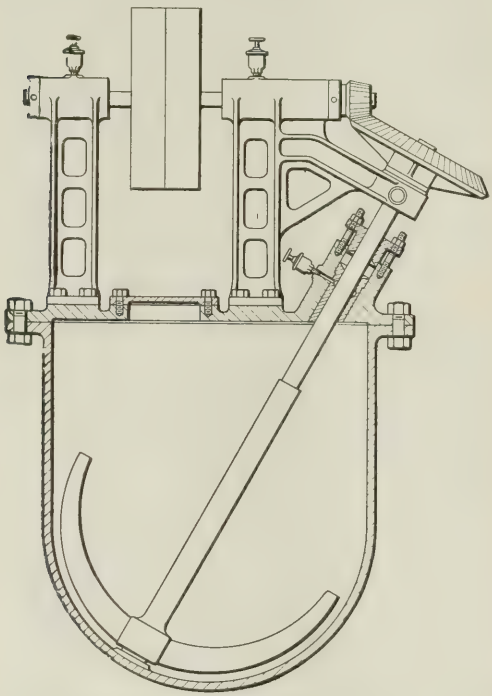


FIG. 5—FUSION KETTLE PROVIDED WITH SLOPING SHAFT AGITATOR

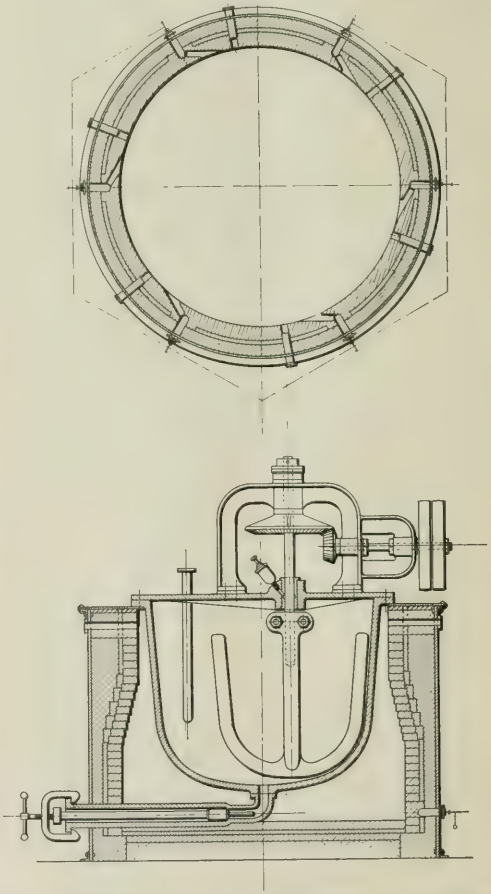


FIG. 6—FUSION KETTLE WITH OFF-CENTER TYPE AGITATOR IN A SETTING EXCELLENTLY ADAPTED FOR FUSION KETTLES WITH BOTTOM DISCHARGE

melting the contents of the discharge pipe. It is impracticable to use a valve or cock of the ordinary type to close the kettle. A successful way of overcoming this difficulty is to use a plug valve, such as shown in Fig. 6. Another method is to protect the pipe shortly after leaving the kettle, then surrounding it with a water jacket through which water is allowed to circulate, and using a plug valve as described (plug valve need not be especially tight). The water circulating through this jacket makes a seal of caustic. When ready to discharge the kettle the flow of water is stopped, the water in the jacket drained off, and the pipe heated up until the melting point of the caustic is reached, when the plug can be removed. This plan works very well, but is unnecessary if the plug valve is well made, is kept clean, and if the proper metals are used for the seat and valve. A number of alloys have been successfully employed for this service, some of the nickel alloys being especially good.

When the kettle is discharged from the top the contents must be either ladled out or the kettle tilted. Tilting is inadvisable for large kettles, except in instances that demand such a method of discharge. In other cases the design is such that the complete kettle and furnace tilt, the tilting mechanism being either a gear and worm or levers.

The contents of the kettle may be pumped out, either by using a centrifugal pump driven by a motor at the end of a long shaft, the centrifugal pump being lowered into the fusion kettle, or the kettle may be emptied by means of an injector with suction pipe extending to the bottom of the kettle.

In the case of an autoclave operating at high pressure, bottom discharge is not practicable. An autoclave is discharged either by first cooling and inserting a pipe to the bottom and "blowing" the charge by means of compressed air, gas or steam, or the cover of the autoclave may be taken off and the contents removed through the top.

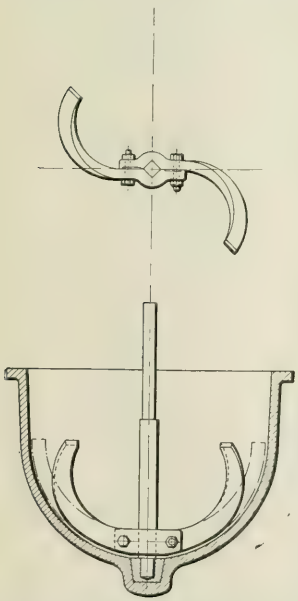


FIG. 7—METHOD OF CONSTRUCTING AGITATORS WHICH HAS BEEN EXTENSIVELY USED

In many instances it is possible to discharge an autoclave by means of a valve and discharge pipe attached to the cover of the autoclave, proceeding as follows: The contents of the apparatus is cooled to a determined temperature, the valve is then opened rapidly, most of the contents being discharged by belching action, the solids being carried out with the rush of gases. The balance of the contents may be removed by a pipe extending to the bottom and "blowing" with steam or compressed air, as before mentioned. In many cases, however, it is possible to discharge practically the entire contents of the autoclave by the quick opening of the valve on the cover.

Fig. 8 shows an autoclave in which a substance in powdered form is treated with a gas under pressure. In this case it is necessary that a large opening in the bottom be provided to conveniently discharge the autoclave.

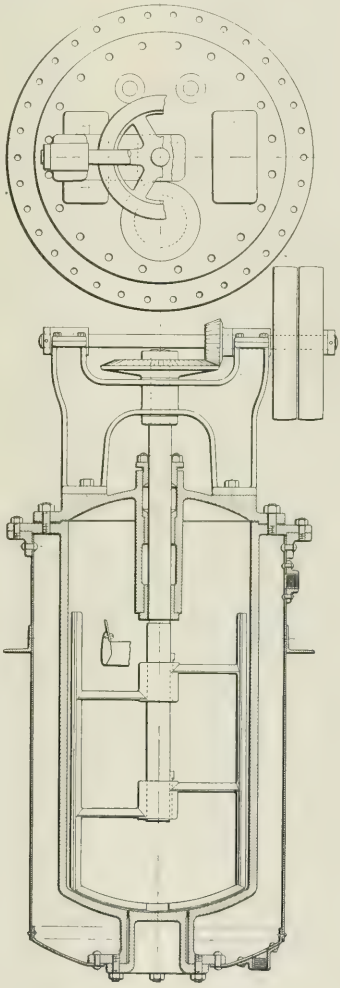


FIG. 8—AUTOCLAVE PROVIDED WITH SCRAPER TYPE AGITATOR AND LARGE DISCHARGE OPENING IN BOTTOM

Low-pressure autoclaves are discharged through an ordinary valve in the ordinary way.

A large variety of furnaces are used in connection with fusion kettles. Fig. 1 shows one adapted for burning crude oil. This is a very satisfactory furnace, is durable, and fairly economical.

Fig. 4 shows a type of furnace for burning coal.

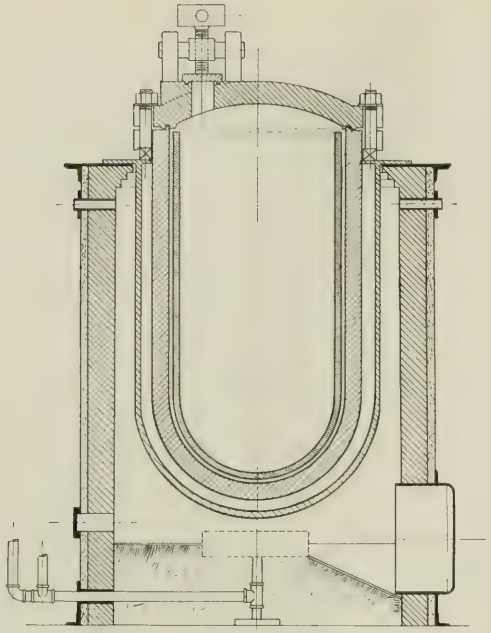


FIG. 9—AUTOCLAVE WITHOUT STIRRING DEVICE, PROVIDED WITH ENAMELED CHEMISE, IN A SETTING FOR BURNING GAS

This is a furnace used in a large phenol plant abroad. It is very satisfactory and most economical. The temperatures can be controlled with considerable accuracy by using the auxiliary door marked *A* for admitting cold air in connection with the dampers marked *B*. The setting is so built that the hot gases may circulate either around the kettle or pass through to the uptake by means of the dampers *B*. This gives a control independent of the fire. Of course, the temperature is also controlled by controlling the fire.

Fig. 6 shows a furnace for burning gas which is rapidly coming into use in this country. It is ideal for many purposes.

Fig. 9 shows another design for burning gas which is considerably used, but is not as economical as the first one.

In designing an autoclave, the question of lubrication must be given intelligent attention. For the main shaft, hard grease should be used instead of oil.

Fusion kettles should be provided with covers, not only to prevent loss of heat but to protect the workmen. They are usually arranged so that one-half of the cover may be easily opened on a hinge. When the cover of the kettle is so arranged no other opening is necessary for charging. Otherwise, there must be a manhole or some other opening in the cover for charging.

If the fusion is one giving off fumes or vapors, an outlet must be provided for a pipe to carry them off.

The kettle must be provided with a thermometer tube extending well into the mass. This is sometimes a wrought-iron tube with the end closed by welding. A better arrangement is to use a tube cast with a closed end; or, better still, one made from a solid bar, boring out the hole with a gun bit. If the thermometer tube is long, care must be taken that it is well supported to resist the strains occasioned by the moving mass in the kettle. The bulb of the thermometer tube should be packed with a mixture of precipitated copper and graphite, or other substances, such as heavy oil or mercury; *e.g.*, depending upon the temperature and the material of which the thermometer bulb is made.

A recording thermometer is more satisfactory than a simple indicating thermometer. Electric pyrometers are used, and well thought of by some operators. When an electric instrument is used for a battery of kettles there is usually one indicating instrument for all the kettles, arranged through switch connections, so that the temperature in any kettle may be read. The importance of control in a chemical factory is becoming more and more recognized. A recording thermometer is a distinct aid to chemical control.

There are a number of special cast irons on the market that for many purposes are more advantageous than ordinary cast iron. One of these special metals, well chosen for the purpose it is to serve, will give a much longer life to a kettle than ordinary cast iron.

Autoclaves are equipped with safety valves and manometers. Great care must be used in connection with both parts of these pieces of apparatus, in that they are so designed and so arranged that they will not become plugged up from the contents of the autoclave. When a safety valve is used it must be so arranged that it will discharge into a protected place, so that the discharge cannot injure the workmen.

Autoclaves for high pressure are made usually from cast steel or forged steel. When an autoclave is made from cast steel it must be cast bottom down, with a heavy sink head to be machined off. Large autoclaves for very high pressures have been successfully made abroad from forged steel, and are for most purposes superior to cast autoclaves.

It is not the intention that this article shall be a treatise on the detail and design of autoclaves, but the following formula is useful in checking the thickness of the walls of an autoclave:

LAMÉ'S FORMULA

$$t = \frac{d}{2}\left[\left(\frac{h + p}{h - p}\right)^{1/2} - 1\right]$$

t = thickness of autoclave wall.
p = working pressure in autoclave.
d = inside diameter of autoclave.
h = maximum allowable hoop tension at interior of cylinder.

(For further information see Merriman's "Mechanics of Materials.")

It is often necessary that acid fusions be made, in which case a lining must be provided. Lead, silver and nickel have all been successfully used as autoclave linings. In some cases a chemise of enameled metal is used, in which case the space between the chemise and autoclave is filled with lead or similar metal, poured in while molten.

The joint between the cover and autoclave is sometimes troublesome. For this purpose lead is often poured into the groove in the autoclave, a tongue in the cover making the joint against the lead. Copper or silver wire is successfully used in the groove. A flat,

corrugated steel gasket is another successful type. A special gasket known under the trade name of "Flexitallic" has been found successful for many uses.

Fig. 9 shows an autoclave without a stirring device equipped with an enamel chemise. This is an example of the sort of autoclave used for such products as dimethylaniline.

The Effect of Addition Agents in Flotation

By M. H. Thornberry and H. T. Mann

In the great amount of literature published on the subject of flotation, including many articles by able technical men, descriptions of patents covering various flotation processes and data on many of the flotation installations throughout the country, are to be found numerous statements indicating that certain factors, such as slight acidity and alkalinity and the presence of small quantities of soluble salts, have shown marked influence upon the separation of the mineral from the gangue, or in the separation of one mineral from another. Our own experience has confirmed this frequent appearance of a preponderant influence of some wholly unexpected factor, and it is the object of the following investigations to obtain more exact data concerning one class of such factors, namely, the influence of the commoner inorganic salts.

The work as outlined covered tests on three ores: a lead ore from southeast Missouri, a zinc ore from southwest Missouri, and a mixed lead and zinc ore from southwest Missouri. Only a part of the work on the lead ore is reported at this time. However, the portion of the work on the zinc ore already completed is similar in its results, and these data will be published later.

Tests on Lead Slime

The lead ore used in the following experiments is a typical slime from the southeast Missouri lead district. The chemical analysis of one sample is as follows:

	Per Cent		Per Cent
Pb	4.64	Cu	0.00
Zn	0.30	CaO	22.68
Fe	3.51	MgO	13.11
S	3.57	Insoluble	16.68

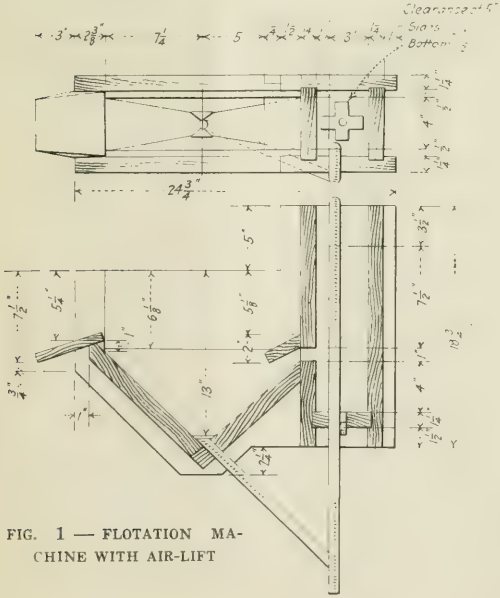


FIG. 1 — FLOTATION MACHINE WITH AIR-LIFT

The screen analysis of this material shows the following results:

	Mesh	Average Size of Opening, Mm.	Percentage	Per Cent, Lead
On	28	0.589	0.00	0.00
On	35	0.417	1.00	1.21
On	48	0.295	0.60	2.82
On	65	0.208	1.60	3.20
On	100	0.147	4.60	3.07
On	150	0.104	15.20	3.41
On	200	0.074	36.80	4.87
Through	200	....	40.20	6.14

Tyler standard screens were used and the material was shaken for 40 minutes on the Ro-Tap.

This slime was barreled wet and when received it contained from 10 per cent to 15 per cent moisture. The material was not dried, and as our water supply has practically the same analysis as the water with the ore, tap water was used in the tests, since it was thought no advantage could be gained by the use of distilled water. The feed did not contain a constant percentage of lead in all experiments, but the variation was small, ranging from 4.30 per cent to 4.64 per cent lead. This is due to the fact that more than one barrel of pulp was used in these tests.

All solutions and emulsions contained 5 per cent of the salt by weight in water. The quantities used were 5 cc., 15 cc., 25 cc. and 50 cc. per charge of approximately 800 grams of dry ore. These quantities are equivalent to 0.625, 1.875, 3.125 and 6.25 lb. respectively of the salt per ton of dry ore.

Flotation Machine with Air-Lift

The machine used for this work was designed in the flotation laboratory and built in the school shops, and is a modified form of the Minerals Separation type machine as illustrated and described in the *Engineering and Mining Journal* of September 4, 1915.

It was found that the original machine did not have sufficient suction to keep either a charge of coarse ore or a charge of ore with a high sulphide content in circulation, hence the air-lift was substituted to overcome this difficulty. This particular type of machine, with all modifications, produces a concentrate having a higher metallic content than that produced in the original machine, due to the fact that it gives a greater area for froth and at the same time allows the froth to accumulate at a point where the currents due to the inflow of pulp from the agitation compartment have little effect. A drawing of the apparatus is shown in Fig. 1.

The various modifications of the original machine may be found in the Missouri School of Mines *Bulletin*, Vol. 3, No. 1.

Conditions of Experiments

Tests were first run on this ore with a large variety of oils from which three were selected for this work. The results on each oil have been plotted and may be found in accompanying charts. Chart I shows the results obtained with Cleveland Cliffs Iron Company's flotation oil No. 1 (hardwood creosote). Chart II shows the results obtained with General Naval Stores

flotation oil No. 17, and Chart III shows the results obtained with cresylic acid.

The method of conducting the experiments is as follows: The moisture was determined and a charge of wet pulp containing approximately 800 gm. of dry ore was weighed and poured into the machine with sufficient tap water to give the charge a dilution of five of water to one of dry ore by weight. The machine was started and the desired quantity of the reagent added. After a thorough mixing oil was added at the rate of 0.5 lb. per ton and the froth skimmed off as fast as it raised above the overflow of the machine. A bubble column of about 2 in. was carried until the very last of the experiment when all froth was skimmed off. This practice undoubtedly, to some extent, raises the extraction and lowers the grade of concentrate, but as this procedure was uniform throughout the results are comparable. The duration of the test was 40 to 45 minutes, and the speed of the machine 1700 r.p.m.

All operating conditions, such as the speed of the impellor, duration of the test, volume of pulp in machine, etc., were kept as uniform as possible. In so large a number of experiments slight variations were unavoidable. These would necessarily cause slight variations in the results obtained; but nearly every result in the charts has been checked once, and where there was a pronounced variation in either extraction or grade of concentrate, the results have been checked several times.

Discussion of Results

In the discussion of the results shown in the charts, the effect of each sulphate with the three oils will be considered separately, after which they will be thrown into groups and considered in a general manner.

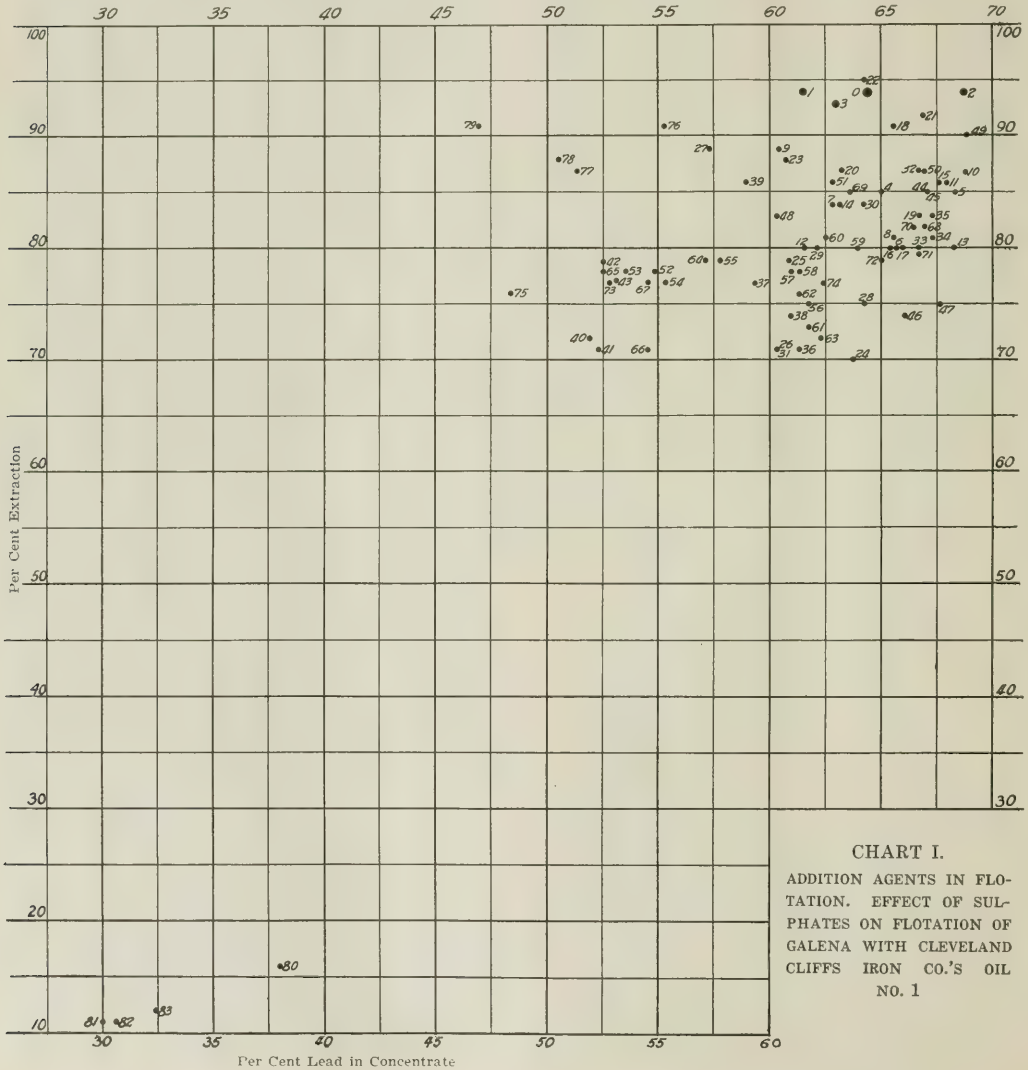


CHART I.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH CLEVELAND CLIFFS IRON CO.'S OIL NO. 1

SULPHURIC ACID AND ALKALI-EARTH SULPHATES

The numerals shown on the charts are the numbers of the various experiments, three being made without any addition agent and four each with the different addition agents. Those without addition agents are numbered 1, 2, 3 and 0, the last showing the average results of the first three. The numbers of experiments with addition agents are given in the following paragraphs, four to each experiment, and indicate results obtained respectively with 5, 15, 25 and 50 cc. of each agent.

H_2SO_4. Nos. 4 to 7. When sulphuric acid is added the extraction is lowered without any apparent change in the grade of concentrate produced. This indicates that southeast Missouri lead ores will give better results without acid than with it.

$MgSO_4$. Nos. 8 to 11. The addition of magnesium sulphate lowers the extraction without any great change in the grade of the concentrate produced.

$CaSO_4.2H_2O$. Nos. 28 to 31. Calcium sulphate gives rather erratic results. With oils which produce a clean concentrate with a good extraction, the presence of this reagent lowers the extraction without any great change in the grade of concentrate produced; but with an oil which tends to lift the gangue, its presence seems to improve the extraction.

$BaSO_4$. Nos. 32 to 35. Barium sulphate has practically the same effect as calcium sulphate.

General. The action of sulphuric acid, which with this ore forms calcium and magnesium sulphates, and the action of the individual sulphates of the alkali earths are very similar. With the exception of barium and calcium sulphates when used with cresylic acid, the extraction is lowered about 10 per cent and there is very little difference in the grade of concentrate produced.

ALKALI SULPHATES

$Na_2SO_4.10H_2O$. Nos. 24 to 27. The presence of sodium sulphate seems to have little effect on the grade of concentrate produced, but it does have a noticeable effect on the extraction obtained. The extraction may be better or poorer, depending upon the quantity of sodium sulphate used and on the oil used.

K_2SO_4. Nos. 16 to 19. When potassium sulphate is added, both the extraction and the grade of concentrate are lowered to some extent.

$(NH_4)_2SO_4$. Nos. 52 to 55. The results obtained when using ammonium sulphate shows that the results depend more on the oil used than on the quantity of the salt present in solution. The results do not deviate sufficiently to make experimental work promising.

$KHSO_4$. Nos. 44 to 47. The tendency of potassium acid sulphate is to give a concentrate of slightly higher grade while it decreases the extraction.

$NaHSO_4.H_2O$. Nos. 48 to 51. The results obtained when using sodium acid sulphate are somewhat erratic.

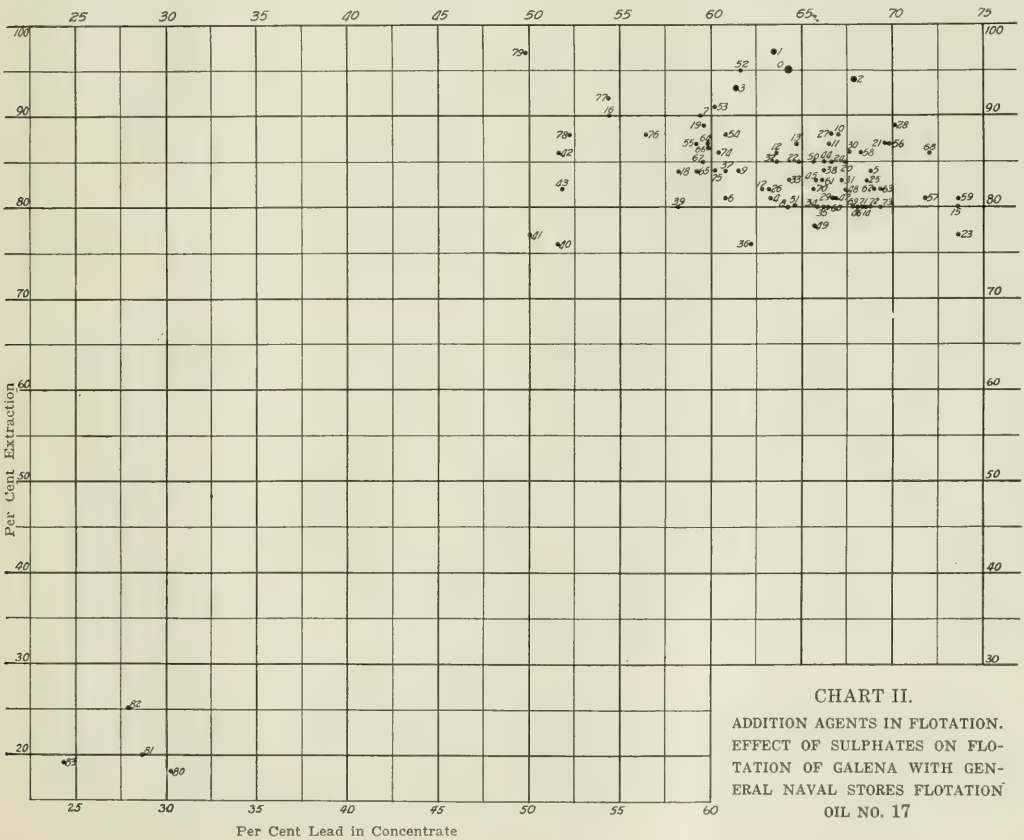


CHART II.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH GENERAL NAVAL STORES FLOTATION OIL NO. 17

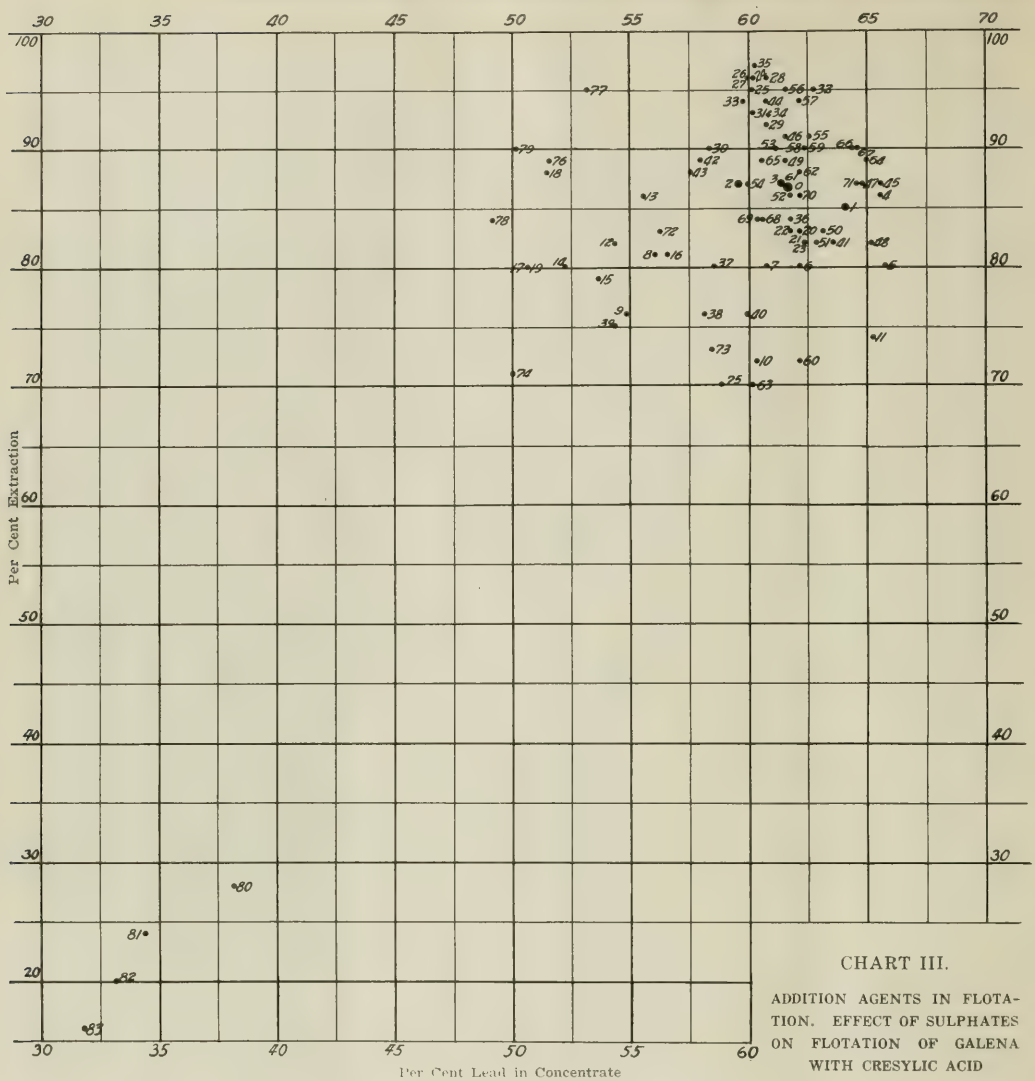


CHART III.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH CRESYLIC ACID

As there are no great variations either in the grade of concentrate or in the extraction, no attempt was made to determine if there were critical quantities which would produce a marked result.

General. The acid and normal sulphates of the alkalies do not show sufficient deviation from each other, either from the results obtained when using oil alone, or from the results of one when compared with the results of another, to make further experimental work desirable at this time.

ALUMS

$Fe(NH_4)_2(SO_4)_2.6H_2O$. Nos. 56 to 59. The concentrate obtained when ferrous ammonium sulphate was added was of a little better grade than that produced with oil alone. The extraction varied with the oil used.

$KAl(SO_4)_2.12H_2O$. Nos. 60 to 63. When potassium alum was used it showed a tendency to improve slightly the grade of concentrate. It lowers the extraction to such an extent, however, that the improvement in the grade of concentrate is of no interest.

$NH_4Al(SO_4)_2.12H_2O$. Nos. 64 to 67. The effect of ammonium alum, when the results are considered as a whole, is to lower both the grade of the concentrate and the extraction.

$NH_4Fe(SO_4)_2.12H_2O$. Nos. 68 to 71. When ammonioferric alum was added, the extractions were lowered considerably with the oils which give a high extraction when used alone. With cresylic acid there is practically no change in the extraction. The grade of concentrate is improved, slightly varying with the oil used.

$KCr(SO_4)_2.12H_2O$. Nos. 72 to 75. When the percentage of lead in the concentrate is considered, chrome alum does not have much effect. The results are rather

erratic, but the extraction is uniformly lowered by the use of this salt.

General. When considering the alums and ferrous ammonium sulphate as a whole, the action of all these salts is very similar to those that have been discussed, and for that reason no further discussion will be attempted.

METALLIC SULPHATES

$MnSO_4.4H_2O$. Nos. 20 to 23. Manganese sulphate when present in solution has little effect on the grade of concentrate produced. It does lower the extraction slightly.

$FeSO_4$. Nos. 12 to 15. The presence of ferrous sulphate causes variable results. With the oils which give a clean concentrate and high extraction, it lowers the extraction but has little effect on the grade of concentrate produced. With cresylic acid the lead tenor of the concentrate produced is noticeably lower.

$HgSO_4$. Nos. 36 to 39. The effect of mercuric sulphate is to lower the extraction without any very great change in the lead content of the concentrate.

$CuSO_4.5H_2O$. Nos. 40 to 43. Copper sulphate lowered the extraction very noticeably and also lowered the lead content of the concentrate. This is just the opposite of the results found in many cases when floating zinc ores.

$ZnSO_4.7H_2O$. Nos. 76 to 79. Zinc sulphate gives variable results. When considering the extractions it will be noted that some of them are a little higher and some slightly lower than when oil alone is used. Taken as a whole, the effect on the extraction is negligible, though it does cause a noticeable lowering of the lead content of the concentrate. When zinc sulphate is present one might be justified in giving the pulp a preliminary water-wash in order to raise the grade of the concentrate and thereby save freight and smelting charges.

$CdSO_4.8H_2O$. Nos. 80 to 83. The presence of cadmium sulphate is very detrimental, practically ruining both the extraction and the grade of concentrate obtained.

Conclusions

Generally speaking, when the sulphates are present the tendency is to lower both the grade of concentrate produced and the extraction. There are, however, a few exceptions to this rule. For instance, when using sodium sulphate with cresylic acid about the same grade of concentrate is produced, but the extraction is noticeably higher. While a few instances may occur in which a certain salt has a slight beneficial effect, this effect is not nearly so pronounced as the detrimental effect of cadmium sulphate. In fact, the position of cadmium is quite unique among the other salts and for this reason it is our intention to publish later a study of the behavior of cadmium salts generally, hence no further discussion of this striking singularity will be attempted here.

The poor extraction obtained when sulphates are present can be overcome in some cases by giving the pulp a longer treatment. This, however, lowers the capacity of a given machine and increases the cost of treatment.

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The Electrolytic Pickling of Steel

M. De Kay Thompson and F. W. Dodson

In a recent article[1] it has been shown that for the kind of mill-scale tested, electrolytic pickling results in a saving in expense over the ordinary chemical method. In these tests all of the scale removed by the chemical treatment was dissolved after the pickling was over, and counted in with the iron dissolved in the pickling operation itself. This gives the most favorable comparison for the electrolytic method. The least favorable comparison for the electrolytic method would be to filter off all the scale right after chemical pickling and analyze for the iron in solution. In the previous experiments the mill-scale used in the tests was made by heating a piece of steel in a muffle, and therefore did not correspond exactly to what must be treated in practice.

The following experiments were made on black sheet-iron kindly furnished by the American Sheet and Tin Plate Company, and on some transformer sheet-iron containing silicon from the General Electric Company. The sheet was cut into sizes that could be placed in a narrow rectangular glass electrolysis vessel 15 cm. long by 15 cm. deep by 5 cm. wide. A number of the sheets were pickled, and the solution was then analyzed for iron. The amount of iron also gives the quantity of acid used. Lead anodes were used and sulphuric acid of specific gravity 1.19. The surface of the black iron after pickling was a silvery white and very clean, quite different from the pickled surface in the previous experiments. The surface of the chemically pickled sheets was not so clean, but was covered by fine black particles which did not wash off easily but which could be removed by rubbing to loosen them and then washing.

In the chemical pickling the sheet-iron was dipped into hot acid 4.5 per cent by weight, and was removed when the pickling was considered complete. The scale which collected at the bottom of the vessel containing the acid was filtered off and the dissolved iron determined by analysis.

The following data are for the sheet-iron from the American Sheet and Tin Plate Company:

Experiment No.	1	2	3	4	5
Amperes	9.1	8.0	8.0	8.0	8.0
Amp. per cm2.	0.058	0.044	0.033	0.047	0.055
Volts	2.70	2.50	2.68	2.90	2.66
Duration of pickling, min.	3.0	2.0	5.25	3.0	3.0
Temperature, deg. C.	59.5	59.5	65.	60.	60.
Sq. cm. pickled	156.	182.	246.	170.	146.

The total area of iron pickled was 900 square centimeters and its weight was 241 grams. The amount of iron dissolved was 2.88 grams, or 0.0032 gram of iron per square centimeter of surface.

Ordinary chemical pickling of the same iron gave the following results:

Experiment No.	1	2	3	4	5
Time	3	8	4	3	6
Square centimeters	111	138	168	183	169
Temperature, deg. C.	100	95	99	99	98

Total area 769 square centimeters, and 2.97 grams of iron were dissolved, or 0.00386 gram per square centimeter. Referring to the weight of the sheets, 1.20 per cent is dissolved by the electrolytic pickling, 1.44 per

[1]Thompson and Mahlman, Tr. Am. Electroch. Soc., May, 1917.

cent by chemical, or a saving of 0.24 per cent by weight of the sheet pickled. In 2000 pounds of black sheet-iron there would be a saving of 4.8 pounds of iron and a corresponding amount of acid. This is a small saving if this were all. The other advantages to be considered are that the surface of the electrolytically pickled iron is much better and that the acid is used at a lower temperature and therefore not so dangerous to the workmen. Also the scale does not fall off to be discarded, but is reduced and practically no iron is lost except that which goes into solution as sulphate.

Samples of silicon transformer sheet-iron from the General Electric Company were next tried. Two kinds of iron were received, one with a blue scale which cracked off when the iron was bent, exposing the white metal beneath. The scale of the other sample had the usual appearance of black sheet-iron. Right under the outside scale in both samples there was a thin layer of rust.

The cell used for pickling the silicon iron was a porcelain cup lined with wax to protect from hydrofluoric acid. Lead anodes were used as in the previous experiments. The pickling liquor was a mixture of 35 per cent by weight of sulphuric and 2 per cent hydrofluoric acids. When pickled electrolytically in this solution the surface came out a silvery white, but it was not possible to do chemical pickling with this solution.

The results with the sample covered with blue, brittle scale were as follows:

Experiment No...	1	2
Amperes	2.5	2.5
Amp. per sq. cm	0.082	0.088
Volts	3.65	2.90
Duration, minutes	10	45
Temperature	20	20
Area, sq. cm	30.6	28.4

Only 0.3 per cent of the weight of the plate was dissolved but an exceptionally long time was required to remove the last particle of scale. Most of it was removed in three minutes.

The following results were obtained with the sample that had more the appearance of ordinary black sheet:

Experiment No.	1	2	3	4
Amperes	3.	3.	3.	3.
Amperes per sq. cm	.067	.071	.070	.073
Volts	3.2	3.1	3.3	3.2
Duration, minutes	5.	4	3	2.
Temperature, deg. C.	24.	24	24.	24

The amount of iron dissolved was 1.3 per cent of the weight of these sheets, or .0016 gram per square centimeter.

The chemical pickling, using the same acid, gave the following results:

Experiment No.	1	2	3	4
Duration, minutes	9	13	9	13
Area, sq. cm	42	40	38	39
Temperature, deg. C.	24	24	24	24

The weight of iron dissolved per square centimeter of surface is 0.002 gram, not very much in excess of that dissolved by the electrolytic pickling.

Summing up the results of the comparative tests of electrolytic and chemical pickling on the kinds of scale tested, these tests do not show any very striking advantage of the electrolytic over the chemical pickling, as far as the amount of acid used is concerned. There are, however, in favor of the electrolytic method, the advantages of using a lower temperature and of getting a better surface. It is very probable that the amount of iron dissolved by the two methods varies considerably with different kinds of scale.

A single test was made on boiler plate which was reported to require two and one-half hours chemical pickling. Eight minutes of electrolytic pickling was found sufficient. It appears therefore that the thicker the scale the greater the relative advantage of the electrolytic method.

The question has been raised as to whether the ferrous sulphate has any appreciable effect on depolarizing the anode. In order to see what this might amount to a diaphragm cell was arranged with sulphuric acid in the cathode, and sulphuric acid in the anode, which could be changed to sulphuric acid and ferrous sulphate without changing anything else about the cell.

It will be seen from the table below that with a large amount of ferrous sulphate the voltage was practically the same as without it. Therefore the small amount of ferrous sulphate in a pickling cell could have no appreciable depolarizing effect.

Other tests were made with practically the same result.

Depolarizing Action of Ferrous Sulphate

	30 per Cent Acid Solution in Anode		30 per Cent Acid and 10 per Cent Ferrous Sulphate Solution in Anode	
Volts	2.85	2.83	2.85	2.90
Amperes	7.2	7.2	7.2	7.2
Temperature, deg. C.	60	60	64	64

Massachusetts Institute of Technology,
Cambridge, Mass.
September, 1917.

Additions to Prohibited Import List

The following articles will require a license by the War Trade Board to be imported, in accordance with a proclamation issued on Nov. 30, by the President: Antimony, antimony ore, or any chemical extracted therefrom; asbestos; beans of all kinds; balata; burlap; castor seed, castor oil; cotton; chrome, chrome ore, or any ferro-alloy or chemical extracted therefrom; cocoanut oil; cobalt, cobalt ore, or any ferro-alloy or chemical extracted therefrom; copra; industrial diamonds; all ferro-alloys; flax; gutta joolatong; gutta percha; gutta siak; hemp; hides and skins; jute; iridium; leather; manganese, manganese ore, or any ferro-alloy or chemical extracted therefrom; mica, molybdenum, molybdenum ore, or any ferro-alloy or chemical extracted therefrom; naxos emery and naxos emery ore; nickel, nickel ore, matte, or any ferro-alloy or chemical extracted therefrom; sodium, potassium; or calcium nitrates; optical glass; palm oil; platinum; plumbago; pyrites; rice, rubber, raw, reclaimed, waste or scrap scheelite; shellac; sisal; soya bean oil; spiegeleisen; sugars; tanning materials; tin in bars, blocks, pigs, or grain or granulated; tin ore and tin concentrates, or any chemical extracted therefrom; titanium, titanium ore, or any ferro-alloy or chemical extracted therefrom; tobacco; tungsten, tungsten ore, or any ferro-alloy or chemical extracted therefrom; vanadium, vanadium ore, or any ferro-alloy or chemical extracted therefrom; wheat and wheat flour; wolframite; or wool.

Efforts of the French Chemical Industries During the War

Among the important changes which have taken place in all the trades and industries of France because of the extraordinary demands of the great war and the unexpected difficulties in obtaining many of the generally used raw products, there are several which have special interest for the American chemical industry.

One of the very latest steps taken in France, says the *Bulletin de la Société d'Encouragement pour L'Industrie Nationale* for July-August, 1917, is that of the manufacture of ashless filters, something which had not before been attempted, and which even now is but in its rudimentary stages. M. Durieux has perfected a type of closed cartridge of cellulose pulp for the filtration of materials dissolved in volatile solvents.

Following the great battle of the Marne, rush orders were given to all powder factories to manufacture at once enormous quantities of powders and other explosives, the consumption of which had surpassed by far all previous calculations. To describe exactly what was done must be left to the future, when the history of the war comes to be written; for the present only a few examples can be given. Phenol and crésol came to France from foreign countries, and not even the distillates of the coal mined and burned in France were used in anything like the extent to which coal tar had entered into the industrial chemistry of Germany. The war department demanded large quantities of trinitrophenol, or picric acid, and trinitrotoluol. The situation had to be worked out in three different directions, therefore.

First, the Gas Light, Heat and Power Company, in its main plant at Gennevilliers, undertook to treat all its tar products, especially those rich in naphthaline, and to recover the phenols and toluols, and some of their higher homologs. These tars were treated with an alkaline solution, and furnished, after acidification, a mixture of phenol products consisting of 12 per cent water, 25 per cent phenol, 12 per cent orthotoluol, 35 per cent meta- and para-toluol, 16 per cent of xylol, etc. Phenol and the toluols are separated from the solution by fractional distillation and crystallization. The company has succeeded recently in producing ortho-toluol, meta-toluol and para-toluol. However, in practical work these two are not separated, as their boiling points are but six-tenths of 1 deg. Cent. apart. When manufacturing explosives, meta- and para-toluol are treated with nitric acid, which transforms the para into oxalic and carbonic acids, while the meta is transformed into trinitrotoluol.

The production of phenol from the coal tar derived in the French gas companies is far too small to be sufficient for the enormous demands of modern warfare (1 ton of coal gives about 1 kg. of crude phenol, which equals about 200 gram of pure phenol). It has been necessary, therefore, to have recourse to the synthetic production of phenol from a benzine base. Synthetic phenol and the intermediary product, benzene sulfonate of sodium, are made at several plants.

The difficulties were finally solved when the Liquid Air Co. and the Chemical Factories of the Rhone undertook the manufacture of dinitrotoluol, starting from chlorobenzine and winding up in dinitrochlorobenzine. Besides dinitrotoluol, several other intermediary products have been made, such as orthonitrochlorobenzine, paranitrochlorobenzine and dichlorodinitrobenzine. Stability of the powders manufactured by these processes was obtained by the use of diphenylamine (in the Rhone factory) and dimethyldiphenylurea.

Chlorine gas was never produced in its pure state, but solely in chemical combination with calcium and hydrogen as CaCl and HCl; now it is made by a number of companies, in the electrolytic and liquid form. Among the new and important explosives manufactured with chlorine as main constituent are chlorobenzene and its derivatives, carbonoxichloride, tetrachloride of tin, and the perchlorates of sodium, potassium and ammonium.

Among the chemical products used in metallurgy which now must be produced in France because of the difficulties of importation should be mentioned ferrocerium, of which one company alone turns out 300 kg. per month. Magnesium is also manufactured in the Clavaux Works, where magnesium chloride is subjected to electrolysis. The largest portion of all the magnesium made here is turned over to another company, which makes a specialty of *duralumin*, an alloy of aluminium, magnesium and copper. This alloy has the density of 2.8, or very nearly that of pure aluminium, yet its strength is nearer that of soft steel.

Three chemical "novelties," so to say, were shown at the chemical exposition held in June last in Paris. They were synthetic acetic acid, synthetic acetic anhydride and synthetic alcohol. All three are directly obtained from acetylene by transformation into acetic aldehyde in the presence of a mercury salt. An oxidizing agent transforms the aldehyde into acid. If acetic acid, under certain conditions, is permitted to act upon acetylene in the presence of a mercury salt, acetic anhydride is formed, which is greatly in demand for the manufacture of acetate of cellulose. If ethylate of aluminium, or a similarly powerful catalyzing agent, is permitted to act upon acetic anhydride in the presence of chloride of aluminum, the anhydride is changed into ethyl acetate, which can easily be transformed into alcohol by saponification.

Not only the manufacture of chemicals, but also the construction of chemical glassware and porcelain apparatus for the laboratories, has furnished French scientists with problems of the most vital and important kind. Shortly after the beginning of 1915, chemical laboratories throughout France felt the lack of Jena and Bohemian glassware, and there seemed no immediate relief in sight. Soon, however, some of the largest glass factories undertook to produce the special kinds of chemical glass needed, according to analyses made of several kinds of Jena and Bohemian glass. Tests which have been made by the laboratory of Arts and Industries show that these glasses are equal in performance to the famous German products, and meet all the requirements demanded by the laboratory at Charlottenburg, Prussia, the clearing house for chemical glassware in Germany. Among the special glass products turned out, and exhibited at Paris, are "tuboserum," which is intended to take the place of the neutral Jena glass, and a drop-counting pipette. Insulated bottles, intended especially for aviators, are now manufactured by M. Berlemont. They were imported heretofore from Germany and Switzerland.

Recent Metallurgical and Chemical Patents

Colored Smoke

Smoke-Producing Compound.—Walter Arthur of Philadelphia, Pa., patents a composition for the production of colored smoke for use in military operations. In military operations it is frequently advisable to indicate, either by the use of lights at night, or smoke in the day time, the position of troops, and the course taken by shells, by the combustion of materials capable of producing distinctive colors. Smoke which is white or black or grayish cannot ordinarily be employed, since such smoke is likely to be confused with the smoke produced by various explosives employed. In the present patent it is proposed to use cadmium metal, finely divided, or an oxidizable compound, such as the sulphide. These produce a brownish smoke, which from a distance has a bright orange appearance. The cadmium metal or cadmium compounds employed are preferably mixed with oxidizing agents, such as nitrates, chlorates, perchlorates, specific examples being barium nitrate, potassium chlorate, ammonium nitrate, potassium perchlorate, sodium nitrate, or mixtures such as potassium nitrate and barium nitrate. The mixture containing the cadmium material and the oxidizing agent can be burned in a variety of ways, as fusee torches, or in some cases merely packages of the powdered material. (1,244,940, Oct. 30, 1917.)

Miscellaneous Chemical Products

Toluene.—A process for the production of toluene and propane from spruce turpentine is patented by Ralph H. McKee of Orono, Me., and assigned to the New Process Gasoline Co. of Philadelphia, Pa. Spruce turpentine is a waste product resulting from the manufacture of cellulose or fibers from spruce and similar woods, such as balsam and fir, by boiling it under pressure in suitable digesters with a solution containing sulphurous acid and a base or bases, such as lime or lime and magnesia, according to what is known as the "sulphite process."

In the practice of the process the spruce turpentine is first separated from the sulphur dioxide gas and tarry products with which it is associated. This purification is effected by distilling the crude turpentine in the presence of steam, the distillation being continued until from approximately 80 per cent to 90 per cent of the original liquid is obtained as a distillate.

The product resulting from the distillation is then passed over calcium chloride to remove water, or is dried by heating or distilling the turpentine until about 2 per cent of such product has been removed by evaporation.

The product thus substantially freed from the impurities referred to, and water, is ready for further treatment. In this treatment some aluminum chloride is added to the product distilled.

Heating the spruce turpentine with aluminium chloride effects a decomposition of the turpentine, the principal products of the reaction being toluene and propane. The toluene is condensed in the distillate and the gaseous propane conducted to a place of use or is stored for future purposes.

It was found that an increased yield of toluene and propane may be obtained from the distillation of the material in the presence of aluminium chloride by passing a stream of hydrochloric acid gas through the liquid while it is being distilled. The rate of flow of the hydrochloric acid gas passed into the material during the distillation process is not of importance, a slow stream of the gas being sufficient to materially increase the yield of toluene. (1,244,444, Oct. 23, 1917.)

Oxidation of Ammonia.—Walter S. Landis of Niagara Falls, N. Y., patents a process of oxidizing ammonia to nitrose gases. The patent is assigned to Frank S. Washburn of Nashville, Tenn. In previous patents (abstracted in this journal Nov. 1, 1916, p. 539, Patents 1,193,798-99-800 of Aug. 8, 1916) the essential principles governing the successful oxidation of ammonia to nitrose gases were described, and it was pointed out if a high efficiency is to be attained a large excess of air should be mixed with the ammonia before passing the catalyzer. It was also shown that this excess of air rendered it necessary to heat the catalyzers from outside sources in order to keep up the combustion. In this invention the necessity of artificially heating the catalyzers is avoided by enriching the air to be mixed with the ammonia with a quantity of oxygen to make the reaction self-propagating. That is to say, if instead of using atmospheric air containing, say, 20 per cent oxygen and 80 per cent nitrogen, one employs an enriched air containing say 30 per cent to 40 per cent oxygen the catalytic oxidizing reaction becomes self-supporting, even though an excess of air is employed, and the catalyzers need not in such cases be artificially heated, except incidentally or to start the reaction. It has also been found that a convenient method of obtaining this enriched air, is by liquefying atmospheric air, and permitting the nitrogen to boil off until about 40 per cent oxygen or a somewhat higher percentage is left. The ammonia used in this process can be conveniently obtained by treating calcium cyanamid with steam, and the nitrogen boiled off can be conveniently used in the manufacture of said cyanamid. It therefore follows that the waste gases from a liquid-air plant producing nitrogen can be employed to eliminate the necessity of heating the catalyzers after the reaction starts, it being only necessary to raise them to an initial starting temperature, after which the reaction is so strongly exothermic that it will continue of itself. In the use of ordinary air, the concentration of the nitrose gases coming from the catalyzers is often not above 6 per cent to 10 per cent; but by employing an enriched gas, on the other hand, such as that disclosed, concentrations of exit gases of at least double these values are claimed to be easily attained. (1,242,953, Oct. 16, 1917.)

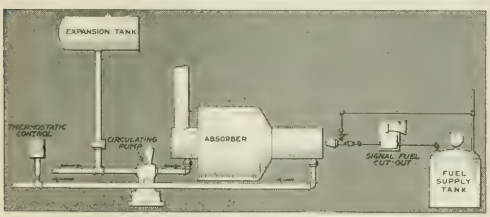
Rensselaer Polytechnic Institute is having extensive additions made to the laboratories of the department of chemistry. Entirely new and complete laboratories will be constructed for quantitative analysis, for organic chemistry and for physical chemistry. Material enlargement will be provided for the food analysis and gas analysis laboratories, and new space assigned for lecture room and recitation room needs. The great increase in number of students entering for the course in chemical engineering has demanded these extensions. Work on the new construction will be started in March, 1918, at which time also ground will be broken for four new dormitories.

An Oil Heating System for Industrial Processes

A system of heat transmission using a mineral oil of high boiling point has been developed by the Merrill Process Company of 70 Devonshire Street, Boston, Mass. The process may be used to increase the fluidity of viscous materials, furnishing heat to ovens, distilling apparatus, heating products which give off inflammable vapors, vulcanizers, melting kettles, calender rolls, etc. The fluid used is called meprolene and is a viscous mineral fluid which is not affected by temperatures up to and somewhat above 600° F. Because of this feature it is possible, when necessary, to obtain working temperatures up to 550° F. with absolute safety as only negligible pressure is created in the system. This is considerably above the possibilities of saturated or superheated steam.

Referring to the diagram, Fig. 1, the circulating heating fluid is supplied to the system from the expansion tank and is circulated through the absorber where the heat is applied by an intense flame from an oil or gas burner. Suitable baffling of the gases assures high heat economy. In general, the burner, if using oil or kerosene, is operated by air pressure. After absorbing the heat transferred to it in the absorber, the fluid passes along to the tank, oven, machine, or whatever form of heat exchanger is being used to transfer its heat. Circulation is accomplished by a positive circulating pump, usually motor driven. Any excess pressure through accident is provided for by properly arranged relief valves. In addition, if, from any cause, the pump ceases to operate, the fuel supply is automatically cut off and an electric warning signal sounded.

If the temperature of the circulating fluid arises beyond a predetermined point, an automatic thermostatic regulator restricts the fuel supply, which permits of a close control at the required temperature. The expansion tank permits expansion, which is negligible, in the



DIAGRAMMATIC ARRANGEMENT OF THE MERRILL PROCESS OF HEAT TRANSMISSION

system due to the heating of the fluid and maintains the pressure at a proper point. The whole system may be closely and positively governed by thermal or electrical control.

Among the applications of the process which have already been developed are those of heating liquids in tanks or vats, operating distilling apparatus where temperatures up to 550° F. are required, in vulcanizing, in japanning and enamelling ovens, and in heating, calendering or finishing rolls. It may be used as an economizer in boiler flue gases. It may also be adopted to prevent the necessity for changing a power plant to provide boilers for furnishing heat that is not required in the form of steam.

Personal

Mr. H. W. ALDRICH, superintendent of the Ladysmith Smelting Corporation, Ladysmith, B. C., has resigned and joined the staff of the Anaconda Copper Mining Co.

Dr. RAYMOND F. BACON, director of the Mellon Institute of the University of Pittsburgh, will be commissioned a lieutenant-colonel in the Ordnance Department of the Army, and will be directed to take charge of the chemical work for our armies in France.

Professor E. BARTOW of the University of Illinois has been commissioned as a major in the Army Reserve Corps. He will go to France to take charge of the sanitary conditions of our army camps.

Mr. FRANK L. ESTEP has resigned as chief engineer of the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., and on Dec. 1 will become chief engineer of the Nova Scotia Steel & Coal Co., New Glasgow, Nova Scotia. He has been connected with the Tennessee company for the past eight years, first as assistant chief engineer, being promoted to his present position on the resignation of E. J. Best in 1912.

Mr. WILLIAM M. KERR, assistant treasurer of the General Chemical Company and manager of the Philadelphia offices of the company, has been elected a director, to succeed Edward H. Rising, deceased.

Mr. H. GARDNER MCKERROW, for the past two years connected with the textile department of the Marden, Orth & Hastings Corporation of New York, has resigned to take up the management of the textile department of E. F. Drew & Company, Inc., which concern operates oil plants in Philadelphia and other cities. Mr. McKerrow, who is a specialist in coal-tar dyestuffs, textile chemicals and textile oils, will look after that line of work for the Drew interests.

Mr. C. A. MACE has been appointed as the head of the textile department of the Marden, Orth & Hastings Corporation, succeeding H. Gardner McKerrow. Mr. Mace has been for eight years with the Badische organization, at the head of the Chicago offices of the latter concern. He is a graduate of Massachusetts Institute of Technology.

The Michigan Smelting & Refining Co. announces that CHARLES T. BRAGG will take the position of works manager of its Detroit plant January 1, 1918. He has been chemical engineer of the Ohio Brass Co. for six years and was for four years Technical Director of Berry Bros. of Detroit.

Mr. FREDERICK POPE, of Moses, Pope & Messer, Inc., consulting engineers, of New York, has accepted a commission as captain in the Engineer Officers' Reserve Corps, Gas and Flame Division, which is the Thirtieth Engineers.

Mr. GEORGE G. SCHMIDT, formerly engineer for the Metropolitan Street Railway Co., piping engineer for the Pennsylvania Railroad, Belmont Tunnels and the Ashokan Dam and in erection of about fifty industrial plants of national prominence, is now with the Carrier Engineering Corporation as piping engineer. He will be located at the main office, 39 Cortlandt Street, New York.

Mr. THOMAS M. SKINNER, JR., formerly connected with the erection and operation of the Potash Prod-

ucts Co., Alliance, Neb.; The Hord Alkali Products Co., Lakeside, Neb., and the Mid-Continent Chemical Co., Sand Springs, Okla., is now managing the erection of a large chemical plant in Owens Lake, Cal.

Mr. A. Gordon Spencer, formerly chief chemist with the Canadian Inspection and Testing Laboratories, has opened an office as consulting chemist at 618 Transportation Building, Montreal.

Mr. W. F. Trenary, Jr., with headquarters at 419 Brown-Marx Building, Birmingham, Ala., now represents the Harrison Safety Boiler Works of Philadelphia, manufacturers of the Cochrane Heaters and other steam plant appliances, succeeding Mr. W. R. Jennison, whose connection with that company has terminated.

CURRENT MARKET REPORTS

The Iron and Steel Market

It is commonly reported that there has been a large curtailment in pig-iron production, by reason of shortage of Connellsville coke, with a curtailment in steel production resulting from the curtailment in pig-iron production. This is not correct. Fragmentary information, covering only the shortage of Connellsville coke, has been used, and due allowance has not been made for increased quantities of coke available from other districts. The fact that steel-making pig iron cannot be bought in most of the producing districts is taken as support of the conclusion that pig iron production has been greatly restricted.

In ordinary times it might not be worth while to discuss popular fallacies in a semi-monthly market report of this character, but these are new times, bringing both new conditions and a disappearance or restriction of some channels of information usually open, hence it will be necessary in future to do more enlightened guessing and to set up a more vigilant guard against conclusions reached upon insufficient premises. The trade finds a scarcity of material, hears of an insufficient supply of raw material in certain quarters, and observes that the commercial consumption of steel is constantly decreasing. Government requirements in steel, not closely estimable at any time, are assumed to correspond to guesses previously made, the uncertain character of this factor being disregarded, and the conclusion is reached that the production of steel really has suffered a very material curtailment.

Coke Supplies

It is merely an incident that statistics of the supply of coke are currently available only in the case of Connellsville. It is a product which is regularly shipped, not consumed at point of manufacture, and undue importance is attached to the Connellsville figures. The production of coke (exclusive of gas house) in 1916 was 54,533,585 net tons, of which 19,069,361 tons was by-product and 35,464,224 tons beehive. These are Geological Survey figures. The Connellsville Courier's statistics, covering the Connellsville and lower Connellsville region, all beehive, showed 21,654,502 tons. The amount of coke consumed by iron blast furnaces, as reported by the American Iron and Steel Institute, was 44,431,905 tons. Thus the Connellsville region furnished a trifle less than 40 per cent of the country's coke production. In the first nine months of the respective years Connellsville shipments showed a weekly average of 425,000 tons for 1916 and 356,000 tons for 1917, but the country's pig-iron production showed a negligible decrease, the output of by-product coke having continued to increase. From Oct. 20 to Dec. 1 the Connellsville shipments averaged 304,000 tons, or a further decrease of 52,000 tons weekly. The entire decrease would represent only 2,400,000 tons of pig iron a year, but a part of the decrease was undoubtedly in coke for various fuel purposes, for iron foundry use and for other purposes outside the smelting of iron ore, while as to the remainder a part may be assumed to have been balanced by increased output of by-product coke. The balance remaining may have been made up by increased beehive production elsewhere, and probably was. In the circumstances, the monthly steel ingot production statistics, recently undertaken by the American Iron and Steel Institute, will be awaited with particular interest. They are as likely as not to show an increase for November over October.

Government Steel Requirements

The unknown element is the Government tonnage of steel. While various fragmentary pieces of information, perhaps incorrect at that, have leaked out as to Government orders, the concealment of the total lettings has been successfully achieved. An intelligent consideration of what is known leads to the conclusion that war requirements in steel are greatly exceeding the tentative guesses that have been made in recent months. One observes that as far as possible all the shell factories that were operated in 1916 upon shell orders for the Entente Allies are to be put in operation again, that shell orders have been placed in Canada, to use steel from the United States, and that a thoroughgoing and successful search has been made in the United States for other plants that can be converted for the manufacture of shells. Many new plate mills have been built without attendant steel-making facilities, some even without slabbing mills, depending upon blooming mill slabs to be gathered up wherever the steel can be taken from other employment. The merchant shipbuilding program has been speeded up. Large quantities of steel are being used in the manufacture of locomotives and cars for our Allies and for the United States railroad in France. Orders placed for the latter operation now total 980 80-ton Consolidation locomotives, 1004 narrow gauge gasoline locomotives, 30 saddle tank steam narrow gauge locomotives and 22,772 cars of various descriptions, together with at least 165,000 tons of rails. As to various other steel commodities there is more or less information and the balance of probability is that there is much of which nothing at all is known publicly.

There are various reports of individual plants converting from 60 to almost 100 per cent of their output into steel intended for war use. Instead of assuming that these reports are exaggerations or refer to cases in which the participation in war steel production is much above the average, it is better to conclude that there is something in it.

Commercial Demand

Commercial demand for steel has continued to decrease and is apparently very light, for there is little

buying pressure in the open market and specifications on contracts are much lighter than formerly. In view of the large volume of contract business on books they can still be large in tonnage even though light in proportion to the tonnages covered by the contracts. The offerings of finished steel products in the open market are extremely light, but they do not by any means represent all the steel that is really available for sale. Prices are set and when steel is scarce mills prefer to give it to their regular customers, more business being done than is openly reported.

Traffic Conditions

Although the current production of steel is probably equal to the best records of recent months and would therefore be between 5 and 10 per cent in excess of the average production in 1916, it is much less than capacity. Production of both pig iron and steel would have been greater of late had there been sufficient transportation facilities, particularly for the movement of coke. Supplies of coal for by-product coking and for steel mill operation, particularly in the Youngstown district, were inadequate for some time, but in the past fortnight have been very nearly equal to all requirements. The railroad situation is now taken in hand by Congress, following the report of the Interstate Commerce Commission presented Dec. 6, to the effect that the railroads should be permitted to form a general pool or should be taken over by the President. By decision Nov. 24 of the Railroads' War Board, after consultation with various Government departments, the railroads east of Chicago had formed a pool of their physical facilities, to the extent necessary to produce maximum freight movement, and even this operation has helped. Except for such effects as may be produced by winter weather, the production of pig iron and of steel promises to make new records in the next few months.

With only minor and relatively unimportant exceptions market transactions in pig iron, unfinished steel and finished steel products have been at the set prices. The system of control by voluntary agreement between the Government and the producers has worked very well indeed. Difficulties of the buyer are due either to the physical scarcity of the material or to his not having a regular source of supply. The habitual shopper, or "professional buyer" as he is euphoniously dubbed in the trade, has particular difficulty in placing orders at this time.

Non-Ferrous Metal Market

Saturday, Dec. 8.—The metal markets are all inactive and prices are unchanged in practically all cases. Copper remains the same at the Government price. Tin is very scarce and quotations are nominal. Lead is firm at unchanged prices. Spelter is dull and unchanged. Antimony is a trifle higher.

Copper.—Most of the large buyers are engaged on Government work and there is no large market for copper. The prices of 23.50 to large buyers and 24.67½ or 5 per cent above 23.50 for small lots as set by the Government remain.

Tin.—Tin is very scarce and there is practically no change in the spot situation on Straits, which is quoted nominally at 80.00 to 85.00 cents. No. 1 Chinese has been offered at 64.00 cents for prompt delivery. The American Iron and Steel Institute, through its subcommittee on tin, has been placed in control of the tin market by the War Industries Board. It will have charge of imports and distribution. Arrivals in November were very low and this accounts for the scarcity of supplies. The tin in warehouses has been released by the Government subject to distribution by the American Iron and Steel Institute. The London market is very high and £294 per ton has been quoted.

Lead.—The market has been very dull and prices remain at 6.25 cents Trust and 6.25-6.50 outside.

Spelter.—Demand has been very slight and prime Western remains at 7.75 to 8.00 cents. The Government has not yet decided on the regulation of prices, and producers are waiting to see what will be given out as to requirements and prices.

Antimony.—Antimony is quoted at 15.00 to 15.50 cents for Chinese and Japanese. Antimony and its ore will be subject to import license, and the metal has consequently advanced.

Tungsten.—Tungsten is subject to import license and considerable ore shipped from South America will be affected at least temporarily. Sellers are asking $23.00-26.00 for wolframite and $27.00 for schulite.

Molybdenum.—The demand is reported good for early delivery with arrivals slow. Molybdenite is $2.25, with $2.50 quoted for sodium molybdate per pound of Mo.

Chrome.—All grades of chrome ore are very scarce.

Quicksilver.—California has jumped to $115.00 per flask with Mexican Virgin held above $113. Recovered mercury is scarce, with $110 offered.

OTHER METALS

Aluminium, lb.	.36–.38
Bismuth, lb.	3.50
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	.55
Silver, oz.	.85⅜
Platinum, oz.	105.00
Palladium, oz.	125.00

Chemical Market

Coal Tar Products.—There has been more interest shown in these products than in the heavy chemicals, and, owing to the peculiar situation governing toluol, intermediates from that base have been scarce and offered in a restricted manner. Phenol has come in for much attention. The general coal tar situation gives promise of interesting events.

Benzol was the weak feature of the market, with sales reported at low figures, caused by surplus quantities backing up on the market.

Toluol has not been traded in, because of governmental seizure of the product, such business as is passing is in the way of fulfillment of old contracts.

Naphthalene was fairly firm, with offerings restricted and the demand quiet.

Phenol was firm and offerings were much restricted. The governmental authorities have also seized considerable of this product and producers are therefore disinclined to offer.

Benzoate of Soda is firm, with spot stock at a low ebb.

Monorchlorbenzol.—The demand is so slack of late that some producers are not quoting. Offers of quantities at concessions seemingly do not interest buyers.

Metanitraniline.—The demand is not heavy and prices are unchanged.

Aniline Salt.—Buyers are covering only for immediate requirements and concessions are offered for quantities.

Aniline Oil.—There is a somewhat improved tone prevailing, because of heavy buying of late.

Para Toluidine.—The market is firm, with offerings restricted.

Ortho Toluidine.—The production is confined to a few quarters and offerings are restricted, with quotations unchanged.

Tolidin.—Only a few producers are offering at this time, and a firm situation prevails.

Salicylic Acid.—The production has increased and prices are a few cents lower, with the demand slightly subsided.

Gamma Acid.—Several inquiries are in the market, but spot material appears scarce, with a firm position obtaining.

N. & W. Acid.—There does not appear to be a great demand, and prices are unchanged.

Para Amido Phenol.—There is considerable competition, but prices are upheld in fair shape by prices of raw material.

Heavy Chemicals.—As a result of many uncertain factors that have developed concerning the marketing of chemicals at the present time the situation from the sellers' viewpoint is very disappointing at the moment. Soda ash has been added to the conservation list, and this means that licenses will be difficult to secure. Caustic soda having previously been added, the export trade in alkalis is now practically suspended.

Caustic Soda.—As a result of bearish interest which seems to be gathering strength day by day, the market has been subject to a marked drop. As the situation has been in control of second hands for many months, these interests are more inclined to become panicky when a pronounced selling effort appears. From the works, however, there has not been much change. For 1918, 6.60 to 6.65 flat, New York, is quoted, and cannot be shaded much. From second hands holding contracts this figure can be shaded fifteen to twenty points, but the uncertainty of deliveries makes a buyer inclined to go to producers rather than to some of the irresponsible dealers now operating. The courts are full of cases concerning caustic soda deliveries.

Soda Ash.—As a result of a presidential proclamation placing the product on the conservation list, there has been a sharp break in values, particularly for double bags and barrels, which packages have been used for export purposes. Naturally single bags for domestic consumption have weakened somewhat, and there is but little likelihood of any special activity until the market has been readjusted to the new state of affairs.

Bichromate of Soda.—In view of the fact that 1918 contracts are being offered at 16½c., with reports of sales at even lower figures, the spot situation has weakened and offers at 17c. have not found buyers. At least one new producer, and possibly more, are planning a production next year.

Chlorate of Potash.—While the 1918 figure on chlorate has not yet been established, it will probably be under 40c., as against 70c. last year. As a result of this condition there has been a very eager desire to unload chlorate delivered on 1917 contracts, and the market has been in some instances 50 per cent under the contract price, representing a loss of 35c. a pound to the seller.

Cyanide of Soda.—The situation has been very quiet indeed and offers, particularly from out-of-town points, have been made at very low figures, without, however, attracting particular attention.

Sulphuric Acid.—While no one appears to have positive official action concerning the plans of the government, it is generally conceded that the plants will furnish 66 brimstone acid to the government at $28.00, works. Probably the brimstone or the pyrites will be furnished at a certain price and the figure will allow of a fair manufacturing profit. Practically all acid now is of the higher concentration.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, DEC. 7, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.36 —	.37
Acid, acetic, 28 per cent	lb.	.05¾—	.06
Acetic, 56 per cent	lb.	.11¾ —	.12¼
Acetic, glacial, 99½ per cent, carboys	lb.	.40 —	.50
Boric, crystals	lb.	.14 —	.14¾
Citric, crystals	lb.	.75 —	.78
Hydrochloric, C.P	lb.	.08¼—	.08¾
Hydrochloric, 20 deg	lb.	.02½—	.02⅝
Hydrochloric, C.P., conc., 22 deg	lb.	.02¼—	.02⅝
Hydrofluoric, 30 per cent, in barrels	lb.	.06¾—	.06½
Lactic, 44 per cent	lb.	.15½—	.16½
Lactic, 22 per cent	lb.	.06¾—	.07¼
Nitric 36 deg	lb.	.06½	.07
Nitric, 42 deg	lb.	.09¼—	.10
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 47 per cent-50 per cent	lb.	.07½—	....
Picric	lb.	.75 —	.85
Pyrallic, resublimed	lb.	3.15 —	3.25
Sulphuric, 60 deg	ton	25.00 —	30.00
Sulphuric, 66 deg	ton	36.00 —	40.00
Sulphuric, oleum (Fuming), tank cars	ton	60 00 —	....
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.79 —	.82
Tungstic, per lb. of W	lb.	1.80 —	1.90
Alcohol, sugar cane, 188 proof	gal.	5.20 —	5.40
Alcohol, wood, 95 per cent	gal.	1.20 —	1.22
Alcohol, denatured, 180 proof	gal.	.84 —	.86
Alum, ammonia lump	lb.	.04½—	.05
Alum, chrome ammonium	lb.	.18½ —	.19
Alum, chrome potassium	lb.	.24½ —	.25¼
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.09¾ —	.09½
Aluminum sulphate, technical	lb.	.02½ —	.03¼
Aluminium sulphate, iron free	lb.	.03½—	.04
Ammonia aqua, 26 deg. carboys	lb.	20 —	21
Ammonium carbonate	lb.	.10 —	.11
Ammonium nitrate	lb.	18 —	20
Ammonium, sulphate domestic	lb.	.07⅛—	7.15
Amyl acetate	gal.	5.25 —	5.40
Arsenic white	lb.	.16 —	.16½
Arsenic, red	lb.	.50 —	.60
Barium carbonate, 99 per cent	ton	70 00 —	....
Barium carbonate 97-98 per cent	ton	65 00 —	67.00
Barium chloride	ton	85.00 —	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½ —	.04
Barium nitrate	lb.	.10½ —	.11
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01½—	.03
Borax, crystals, sacks	lb.	.07¾ —	.08½
Brimstone, crude	ton	60.00 —	65.00
Bromine, technical	lb.	.65 —	.70
Calcium, acetate, crude	lb.	.06 —	.06⅛
Calcium, carbide	lb.	.08½—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	21.00 —	22.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	.... —	....
Carbon bisulphide	lb.	.07 —	.07½
Carbon tetrachloride, drums	lb.	.15¾ —	.16¼
Caustic potash, 88-92 per cent	lb.	.84 —	.84½
Caustic soda, 76 per cent	lb.	.07¼—	.08
Chlorine, liquid	lb.	.15 —	.18
Cobalt oxide	lb.	1.40 —	1.50
Copperas	lb.	.01¼—	.01½
Copper carbonate	lb.	.45 —	....
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09½—	.09¾
Cream of tartar, crystals	lb.	.55 —	.57
Epsom salt, bags	lb.	.03¼—	.04
Formaldehyde, 40 per cent	lb.	.19 —	.20
Glauber's salt	100 lb.	.80	.85
Glycerine, bulk, C. P	lb.	.70 —	.71
Iodine, resublimed	lb.	4.25 —	4.35
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17½—	.19
Lead arsenate	lb.	.16 —	.20
Lead nitrate	lb.	.17½—	.18
Litharge, American	lb.	.09½—	.11½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.48 —	.55
Magnesium carbonate, tech	lb.	.09¾ —	.10
Nickel salt, single	lb.	.14½—	....
Nickel salt, double	lb.	.11½—	....
Phosphorus, red	lb.	1.70 —	....
Phosphorus, yellow	lb.	2.10 —	2.15
Potassium bichromate	lb.	.45 —	.46
Potassium bromide granular	lb.	1.45 —	1.50

Potassium carbonate calcined, 85-90 per cent	lb.	.75	—	....
Potassium chlorate, crystals	lb.	.42	—	.44
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	330.00	—	345.00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.70	—	3.00
Potassium prussiate, yellow	lb.	1.27	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	400.00	—	....
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.15	—	....
Salammoniac, white gran	lb.	.18	—	.18½
Sal soda	100 lb.	1.15	—	1.25
Salt cake	100 lb.	1.50	—	2.00
Silver cyanide, based on market price of silver	oz.	....	—	....
Silver nitrate	oz.	.57	—	.59
Soda ash, 58 per cent. light, flat	100 lb.	2.90	—	3.00
Soda ash, 58 per cent, dense, flat	100 lb.	4.00	—	....
Sodium acetate	lb.	.14	—	.15
Sodium benzoate	lb.	3.00	—	....
Sodium bicarbonate, domestic	lb.	.02⅝	—	.03
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.18½	—	.20
Sodium bisulphite, powd	lb.	.06¼	—	.06½
Sodium chlorate	lb.	.24½	—	.25
Sodium cyanide	lb.	.48	—	.51
Sodium fluoride, commercial	lb.	.18½	—	....
Sodium hyposulphite	lb.	....	—	....
Sodium molybdate, per lb. of Mo	lb.	2.50	—	....
Sodium nitrate, 95%	100 lb.	4.65	—	4.75
Sodium nitrite	lb.	.30	—	.35
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate	lb.	.04	—	.04½
Sodium prussiate, yellow	lb.	.36	—	.37
Sodium sulphate, liquid	100 lb.	1.80	—	2.00
Sodium sulphide, 30 per cent crystals	lb.	.02½	—	.03½
Sodium sulphide, 60 per cent, fused	lb.	.04	—	.04½
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	.23¾	—	.24
Tin oxide	lb.	.72	—	.73
Zinc carbonate	lb.	.35	—	.38
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	....
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.16	—	.17
Zinc sulphate	lb.	.05½	—	.05¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.40	—	.42
Benz l, 90 per cent	gal.	....	—	....
Toluol, pure water white	gal.	Nominal		
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carb lic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.10	—	....
Alpha naphthol, distilled	lb.	1.60	—	....
Alpha naphthylamin	lb.	.58	—	.60
Aniline oil, drums extra	lb.	.25¾	—	.26
Aniline salts	lb.	.31½	—	.33
Anthracene, 80 per cent	lb.	.50	—	....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.80	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	3.00	—	3.10
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.00	—	8.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	2.65
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3.75	—	4.25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.57
Dimethylaniline	lb.	.60	—	.65
Diphenylamine	lb.	1.00	—	....
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.19	—	.22
Naphthalene, flake	lb.	.09½	—	.10
Naphthalene, balls	lb.	.10½	—	.10¾
Naphthionic acid, crude	lb.	1.50	—	1.75
Naphthylamin-di-sulfonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Orth-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	4.50	—	5.00
Para-amido-phenol, H. Ch	lb.	5.25	—	5.75
Paranitraniline	lb.	1.10	—	1.15
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.25	—	....
Phthalic acid anhydride	lb.	6.30	—	6.40
Phenol, U. S. P	lb.	.52	—	.53
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.00	—	13.50
Salicylic acid	lb.	1.28	—	1.30
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	2.50	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....
Fuel Oil				
New York	gal.	.11	—	....
Pittsburgh	gal.	.07½	—	10
Oklahoma-Kans	bbl.	.70	—	1.55
Texas	bbl.	1.50	—	1.75
Los Angeles	bbl.	1.45	—	....
San Francisco	bbl.	1.45	—	....
Gasoline (Wholesale)				
New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.26	—	....
Chicago	gal.	.21	—	....
Oklahoma	gal.	.23	—	....
San Francisco	gal.	.20½	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	....
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—	....
Pine oil, destructively distilled	gal.	.43	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.32	—	....
Turpentine, crude, sp. gr. 0.940-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—	....
Wood creosote, ref. f.o.b. Florida	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.22	—	.23
Cottonseed oil, crude	gal.	1.24	—	....
Linseed oil, raw, cars	gal.	1.20	—	....
Peanut oil, crude	gal.	1.30	—	....
Rosin oil, first run	gal.	.35	—	....
Rosin oil, fourth run	gal.	.66	—	....
Soya bean oil, Manchuria	lb.	.17¼	—	.17½
Turpentine, spirits	gal.	.50	—	.51

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Carnauba wax, flor	lb.	.67	—	....
Cascin	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	....	—	....
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb	bbl.	7.20	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y	ton	160.00	—	....
Ferrochromium, per lb. of Cr	lb.	.40	—	.45
Ferromanganese, domestic	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	5.00	—	....
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	....	—	....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	160.00	—	....
Ferrosilicon, 50 per cent, contract	ton	100.00	—	175.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	....
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Antimony ore, per unit		1.60	—	1.70
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton	....	—	.90
Manganese ore, 48 per cent and over, per unit	ton	....	—	1.20
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	2.15	—	2.25
Tungsten, Scheelite, per unit of WO_3	ton	27.00	—	....
Tungsten, Wolframite, per unit of WO_3	ton	23.00	—	26.00
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium Pentoxide, 99%	lb.	....	—	10.50
Pyrites, foreign	unit	.16	—	.16½
Pyrites, domestic	unit	.20	—	....

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The Acme Brass Foundry Company, Pittsburgh, Pa. Capital, $25,000. To operate a local plant. H. I. Wasserstrom, treasurer.

The Allied Chemical Works, Inc., New Orleans, La. Capital, $30,000. To operate a plant for the production of bicarbonate of soda, potash, and other chemicals from hardwood ashes. Incorporators: W. T. King, Donaldson Caffery and Judge Dormon, New Orleans.

The American Cellon Company, Newark, N. J. Capital, $1,000 000. To manufacture chemicals and allied products. Incorporators: Charles B. Copeland, East Orange; Frederick N. Canfield, Charles Hollander, Bronx; John Heiss, Jr., Belleville; A. Rolleri and Joseph A. Weiss, Newark.

The Ash Iron Company, Duluth, Minn. Capital, $500,000. To engage in the production of iron products. Incorporators: Walter B. Congdon, James Wanless and Charles A. Humbert, Duluth; David T. Adams, Chicago, Ill., and K. Todd, St. Paul, Minn.

The Batavia Steel Products Corporation, New York. Capital, $1,000,000., To engage in the production of steel products. Incorporators: George V. Reilly, S. B. Howard and A. W. Britton, 65 Cedar Street, New York.

The Black Hawk Gold Company, Dover, Del. Capital, $5,000,000. To mine for gold.

Blenio, Inc., Washington, D. C. Capital, $200,000. To manufacture fireproofing and waterproofing paints. Incorporators: John W. Dawson, New York; Robert C. Hotson, Westminster, Md., and T. T. Ansberry, Washington.

The Blueridge Chemical Corporation, Rocky Mount, Va. Capital, $150,000. To engage in the manufacture of chemicals and allied products. Incorporators: W. C. Menefee and A. S. Adams.

J. G. Brown, Inc., New York. Capital, $25,000. To manufacture chemicals. Incorporators: T. F. Thornton, D. R. Bernstein and J. G. Brown, 48 Post Avenue.

Brown-Ferrer, Inc., Plainfield, N. J. Capital, $50,000. To operate a local plant for the manufacture of chemicals. Incorporators: G. Clement, John S. Johnston and Louis A. Clement, Plainfield.

The Chicago Montana Manganese Company, Dover, Del. Capital, $300,000. To manufacture and deal in iron and manganese products. Incorporators: C. L. Rimlinger and M. M. Clancy, Wilmington; C. M. Egner, Elkton, Md.

The Commercial Chemical Company, Memphis, Tenn. Capital, $15,000. To manufacture chemicals and kindred products. Incorporators: W. C. Pryor, Robert H. Stickley and S. D. Tucker.

The Coolrite Company, Ithaca, N. Y. Nominal capital, $5,000. To manufacture coolrite and chemical products. Incorporators: A. W. Browne, G. F. Simpson and N. Hanford, Ithaca.

The Corning Foundry Company, Corning, N. Y. Capital, $100,000. To operate a local plant. Incorporators: S. E. Flitner, W. N. Gurnsey and B. W. Wellington, Corning.

The Crescent Ink & Color Company, New York. Capital, $100,000. To manufacture ink and colors. Incorporators: N. A. McManus and A. and J. Alexander, 495 West End Avenue.

The Diamantine Chemical Company, Monessen, Pa. Capital, $100,000. To manufacture chemicals and allied products. Incorporators: Peter Lucarakis and George Stefanides, Monessen, and M. J. Dain, Pittsburgh.

The Electro Products Company, Wilmington, Del. Capital, $500,000. To manufacture machines under electrolytic. chemical and other processes. Incorporators: L. A. Irwin, N. L. Rogers and Harry W. Davis, Wilmington.

The Fuelite Corporation, New York. Capital, $50,000. To manufacture compounds, chemicals, preparations and materials for the treatment of coal, coke, etc. Incorporators: Albert R. Bremer, E. A. and C. Alexander, Yonkers.

The Fyr-Fyter Sales Company of New York, Inc., New York. Capital, $15,000. To manufacture and deal in fire-escapes and chemical compounds. Incorporators: H. R. Ismon, L. A. Birck and W. D. Forster, 120 Broadway.

E. D. Giberson & Company, New York. Capital, $50,000. To manufacture iron and steel products. Incorporators: E. D. and M. F. Giberson and R. D. Whiting, 310 Wadsworth Avenue.

The Goldsmith Brothers Smelting & Refining Company of Georgia, Atlanta, Ga. Capital, $10,000. To operate a local plant. Incorporators: Frank H. Leslie, Atlanta, and L. L. Lewis, Chicago, Ill.

The Great Eastern Paper Company, Bangor, Me. Capital, $1,200,000. To manufacture paper of all kinds. Incorporators: Garret Schenck and Charles W. Mullen.

The H. & H. Foundry Company, Stamford, Conn. Capital, $15,000. To operate a local plant. Incorporators: C. P. Webb, N. Rominello, Benjamin Horris, Stamford, and John Hanson, Greenwich.

The Hartland Chemical Company, Hartland, W. Va. Capital, $10,000. To manufacture chemicals and allied products. Incorporators: D. G. Price and R. M. French, New York; J. A. Jones and O. L. Hall, Clay, W. Va.; R. E. Light, Hartland, W. Va.

The Hercules Electric Steel Corporation, New York. Capital, $50,000. Incorporators: W. L. Scott. A. Heller and W. H. Rich, 110 Liberty Street.

Hollingshurst & Company, New York. Active capital, $10,000. To operate a plant for the manufacture of fertilizers. Incorporators: J. K. Byard, B. O. Graves and M. Spalletta, 120 Broadway.

The Howells Metallurgical Company, Pittsburgh, Pa. Nominal capital, $5,000. T. J. Howells is the principal incorporator.

The Iler Foundry & Manufacturing Company, Columbus, Ohio. Capital. $30,000. To operate a local plant. Incorporators: Elmer E. Cordrey and F. M. Iler, Columbus.

The Keystone Graphite Company, Ashland, Ala. Capital, $150,000. To develop graphite properties. Incorporators: W. W. Bromelsick, A. A. Allen, A. V. Calkins and W. A. Kitchins, Ashland.

The Marland Chemical Company, Ponca City, Okla. Capital, $100,000. To operate a plant for the manufacture of chemicals and allied products. Incorporators: E. W. Marland, J. S. Alcorn and A. L. Bogan.

The National Aniline & Chemical Company, Jersey City, N. J. Capital, $18,959,500. To manufacture chemicals and kindred specialties. Incorporators: J. F. Stone, W. W. McIlray and W. Becker, all of New York.

The National Potash Company, Omaha, Neb. Capital, $500,000. To engage in the manufacture, production, refining and sale of potash. Incorporators: W. P. Haubach, F. A. Waldmann and John B. Potts, Omaha.

The National Reduction Corporation, New York. Capital, $1,100.000. To manufacture turpentine, charcoal and tar. etc., from wood. Incorporators: James H. Kirkpatrick and G. V. Ferguson, New York; Park L. Woodward, Great Kills, S. I.

The Nevin Chemical Company, St. Louis, Mo. Capital, $200,000. To manufacture chemicals, etc. Incorporators: P. Fahle, R. C. and M. J. Hart and Vincent Dempsey, St. Louis.

The Northwest Chemical Company, Spokane, Wash. Nominal capital, $5,000. To manufacture chemicals and sanitary supplies.

The Occidental Chemical Company, Oakland, Cal. Capital, $350,000. To manufacture chemicals and potash specialties. The company will take over and operate the California Chemical Company, Santa Barbara. Incorporators: F. A. Williamson, George H. Morse, H. H. Collier, C. C. Watts and H. G. Tardy, Oakland.

John Opitz, Inc., New York. Capital, $200,000. To manufacture chemicals and allied products. Incorporators: C. J. Opitz, 183 East 143d Street; H. Napretek and H. R. Opitz, Blissville, N. Y.

The Otis Phosphate Company, Benotis, Fla. Capital, $50,000. To operate a phosphate works. Incorporators: James F. Meredith, Fort Myers. Fla.; Otis E. Meredith and B. F. Meredith, Benotis.

The Pacific Reduction & Chemical Company, Tenino, Wash. Capital, $500,000. To operate a smelting works, including a plant for the manufacture of coal briquettes. Incorporators: H. P. Scheel and William McArthur, Tenino, and F. M. Lane, Tacoma, Wash.

The Peach Kaolin Company of Delaware, Philadelphia, Pa. Capital, $50,000. with Delaware charter. To manufacture clay products, etc. Incorporators: Carl N. Martin and J. Elliott Newlin, Philadelphia.

Peper Brothers, Inc., Brooklyn, N. Y. Capital, $35,400. To manufacture chemicals. paints and dyes. Incorporators: G and W., and J. W. Peper, 321 Caton Avenue, Brooklyn.

The Piedmont Pyrites & Mineral Corporation, Madison, Va. Capital, $50,000 To operate a local works for pyrites production, etc. Principal incorporator: J. W. Price.

The Pioneer Oil Refining Company, Bowling Green, Ky. Capital, $100,000. To construct and operate an oil refining plant at Rodimer, Ky. Incorporators: A. Laurie, Toledo. Ohio; L. W. Searles, Birmingham, Ala.; Benjamin H. Briggs, Frankfort, Ky.

The Pioneer Paper Company, Olympia, Wash. Capital, $75,000. To manufacture paper of all kinds.

The Peoples Mutual Lead & Zinc Company, Muhall, Okla. Capital, $1,000,000. To engage in a general mining business. Incorporators: G. M. and W. C. Wolfe and Thurman Ellison, Mulhall.

The Precision Glass Apparatus Company, New York. Capital, $25,000. To manufacture glass apparatus of various kinds. Incorporators: J. C. Foley, L. M. Melchior and W. H. Muncey, 237 East Forty-first Street, New York.

The Premier Rubber Company, Jersey City, N. J. Capital, $100,000. To manufacture rubber goods. Incorporators: A. M. Lowenthal, C. L. Williams and William Lowenthal, all of New York.

John R. Proctor, Inc., 721 Broadway, Bayonne, N. J. Capital, $30,000. To manufacture rubber and metal goods. Incorporators: John R. Proctor and Lewis L. Ransom, Bayonne.

The Radium Chemical Company, Chicago, Ill. Capital, $25,000. To manufacture chemicals and allied products.

The Richvale Steel Company, New York. Capital, $1,000,000. To manufacture steel products and engage in a general mining business. Incorporators: S. B. Howard and A. W. Britten, 65 Cedar Street.

W. B. Scaife & Sons Company, Pittsburgh, Pa. Capital, $850,000. To engage in a general iron and steel business. Incorporators: William B. and J. V. Scaife and M. M. Frey, Jr., Pittsburgh.

The Seneca Paper Company, Geneva, N. Y. Capital, $10,000. To manufacture paper products. Incorporators: P. H. Sheehan, L. Compton and W. P. O'Malley, Geneva.

The Smithers Chemical Company, St. Louis, Mo. Capital, $10,000. To manufacture chemicals. Incorporators: John H. Smithers. F. E. Walsh. John L. Brandt and W. R. Joyce.

The St. Louis Oil & Refining Company, St. Louis. Mo. Capital, $250,000. To construct and operate an oil refining works Incorporators: H. H. Macon, J. L. English and W. B. Harrison, St. Louis.

The Stratford Chemical Works, Newark, N. J. Capital, $250,000, with Delaware charter. Incorporators: W. A. Keener. Newark, and S. Weitzenbluen, New York.

The Tar Heel Manganese Company, Mount Airy, N. C. Capital, $100,000. To engage in a general manganese mining business.

Tuhoy & Lounsbury, Inc., Pennsgrove. N. J. Capital, $25,000. To manufacture chemicals and kindred products. Incorporators: James L. Tuhoy, Harry Lounsbury and M. Tuhoy, Pennsgrove; Charles W. Lounsbury, Salem.

The Union Chemical Company, Memphis. Tenn. Capital, $25,000. To manufacture chemicals. Incorporators: C. M. Jones, E. W. Jones, C. Barnum and T. F. Finley, Memphis.

The United American Metals Corporation, Brooklyn, N. Y. Capital, $500,000. To engage in a general manufacturing and smelting of metals. Incorporators: R. L. Gray, J. A. Burns and G. K. Wilson, 82 Washington Place, New York.

The United States Industrial Chemical Company, Baltimore, Md. Capital, $24,000,000. To operate a plant at Curtis Bay for the manufacture of chemicals, fertilizers, etc.

The United States Potash Products Company, White Plains, N. Y. Capital, $5,500,000, with Delaware charter. To man-

ufacture potash specialties. Incorporators: D. T. Connet, White Plains; J. F. Roach and C. E. Bahn, New York.

The UNIVERSAL GLASS COMPANY, New Kensington, Pa. Capital, $100,000. To manufacture glass of all kinds. Incorporators: C. A. and F. Bloser and H. W. Killian, New Kensington.

The VIRGINIA MANGANESE MINING CORPORATION, Attaway, Va. Capital, $50,000. To develop manganese properties in Virginia. Incorporators: J. W. Ruff and J. L. Phillips, Attaway.

The VITRUMUS COMPANY, Norfolk, Va. Capital, $975,000. To construct and operate a fertilizer manufacturing plant. Principal incorporator: R. W. Gamble, Norfolk.

OTTO P. WEISSWANGE, INC., Mt. Vernon, N. Y. Capital, $50,000. To manufacture precision thermometers and scientific glass apparatus. Incorporators: M. Hertz, H. Weissmann and E. K. Noll, 44 Court Street, Brooklyn.

The YOUNGSTOWN PRESSED STEEL COMPANY, Youngstown, Ohio. Capital, $1,000,000. To manufacture pressed steel, metal lath and kindred specialties. Incorporators: C. A. Manchester, P. J. Jones, R. A. Henderson and Franklin B. Powers, Youngstown.

Construction and Operation

Alabama

BIRMINGHAM.—The Crystalline Flake Graphite Company, 1901 First Avenue, recently incorporated with a capital of $100,000, is planning for the erection of a large plant at Ashland for the development of 236 acres of graphite lands. A. F. Loventhal, Birmingham, is the president and manager of the new company.

BIRMINGHAM.—Fire recently destroyed the plant of the Indian Refining Company, Avenue E and Thirty-second Street, Avondale, near Birmingham, with loss estimated at approximately $125,000. The company is making plans for the immediate rebuilding of the plant, to include the erection of a large warehouse and other buildings. F. A. Chapman is manager.

California

LOS ANGELES.—The American Can Company, Forty-eighth Street and Santa Fe Avenue, Vernon, has filed plans for the erection of a new addition, about 125 x 395 feet. The company recently acquired property adjoining the present works, and is planning for the construction of extensions, to cost approximately $1,100,000. The capacity of the works will be increased to about 2,000,000 cans daily. C. J. Gordon is the local sales manager.

LOS ANGELES.—The Los Angeles Shipbuilding & Drydock Company is planning for the construction of two new shipways, with necessary shop structures, at its shipbuilding works at Smith's Island, Wilmington. The company has been awarded a contract by the Emergency Fleet Corporation for the construction of ten new steel vessels, with capacity of about 8,800 tons.

MARTINEZ.—The Butters Chemical Company is making rapid progress in the construction of a new zinc reduction plant. Work has been commenced on the initial unit of the works, which will be located on property recently acquired from William Peyton.

MONTEBELLO.—The Standard Oil Company has acquired forty acres of land west of the city as a site for the construction of an oil pumping plant. Forty oil storage tanks will be built and an 8-inch pipe line will be laid to the company's refinery at El Segundo.

SACRAMENTO.—The Southern Pacific Railroad is planning for the immediate construction of a large steel manufacturing plant to have capacity of about 150 tons daily, to cost about $500,000. The company will also build a new switch plant to cost $60,000, and a works for the manufacture of crossing frogs and similar apparatus.

Connecticut

WATERBURY.—The American Brass Company, Washington Street, has awarded a contract for the construction of a new one-story brick and steel addition to its plant, about 42 x 51 feet. Chatfield & Chatfield, Waterbury, are the contractors.

WINDSOR LOCKS.—The E. Horton & Son Company, manufacturer of lathe chucks and castings, is making rapid progress in the construction of a new two-story addition to its plant, about 40 x 50 feet.

Florida

PENSACOLA.—The Pensacola Fertilizer & Oil Company has commenced the construction of its proposed new plant at Grassy Cove, to be devoted to the manufacture of fertilizer and oil from menhaden, a small fish found in abundance in the Gulf waters. The plant includes the construction of a dock 250 feet long, and two large factory buildings will be erected, which will form the first unit of the works. When completed, the plant will consist of seven large buildings, and will be the largest fish and oil factory on the Gulf coast. W. U. Erbine, superintendent of the company, is in charge of the construction work.

Illinois

CHICAGO.—The Chicago Stove & Range Company, South Clark Street, has commenced the construction of a new two-story plant, 50 x 200 feet, at Benton Harbor, Mich. J. E. Fitzgerald is president.

CHICAGO.—The Fitzpatrick Brothers Soap Company, 1319 West Thirty-second Place, is building a new soap factory, two, three and four-story and basement, at a cost of about $90,000. Stressenreuter Brothers, 3020 South Halsted Street, Chicago, are the contractors.

CHICAGO.—The Liquid Carbonic Company, Thirty-first and Kedzie Avenue, has had plans prepared for the construction of a new one and one-half story addition to its plant, about 60 x 100 feet.

EAST ST. LOUIS.—The American Coke and Chemical Company, through one of its subsidiaries, will erect a $10,000,000 by-product coke plant at East St. Louis.

ROCK ISLAND.—The Rock Island Plow Company is making rapid progress in the construction of a new one-story addition to its plant on Second Avenue, about 66 x 235 feet. Estimated cost of the structure is $20,000.

SOUTH BARTONVILLE.—The Keystone Steel & Wire Company is making rapid progress in the construction of a two-story addition to its plant, about 120 x 150 feet, to cost $35,000.

Kansas

BAXTER SPRINGS.—The St. Louis Lead & Zinc Company has acquired forty acres of land about two miles south of Baxter Springs, and is planning for the immediate construction of a new 250-ton mill for the mining of ore.

DOUGLASS.—The Liberty Pipe Line & Refining Company has acquired property on the Hiram Haver farm as a site for the construction of a large oil refinery and pipe line to connect with the A-1 fields.

BUTLER.—John M. Alexander, Lincoln, Neb., has announced that all arrangements have been completed for the organization of a new company, to be known as the Reliance Refinery Company. Plans have been perfected for the construction of a new 1,500-barrel refinery on the Piper farm, just north of El Dorado, and it is expected that work will be commenced within a short time.

Louisiana

HARVEY.—Swift & Company, Chicago, have awarded contracts for the erection of their proposed new sulphuric acid plant at Harvey, near New Orleans. The new factory will supply the company's fertilizer plant with sulphuric acid, which heretofore has been purchased in the open market. The works will have a capacity of sixty tons of acid daily, and the buildings, with necessary equipment, are estimated to cost $250,000.

Maine

MECHANIC FALLS.—Fire recently destroyed the plant of the Colonial Paper Company, a three-story brick structure, with loss estimated to be about $40,000.

Maryland

BALTIMORE.—Reus Brothers, 146 West Mount Royal Avenue, are planning for the construction of a new machine shop on property recently acquired, adjoining their plant. The company will also install a new ignition department for repair and maintenance work for automobile systems.

BALTIMORE.—The American Propeller & Manufacturing Company will build a new one-story factory, about 150 x 200 feet, at its plant on East Hamburg Street. The structure is estimated to cost about $60,000. Contracts have been awarded.

BALTIMORE.—The United States Industrial Alcohol Co. is reported to be planning for extensions to its plant to double the capacity. The company will extend its bulkhead line around Flood's Point, which will create several additional acres of land now under water.

Massachusetts

SPRINGFIELD.—The Harley Company is completing the erection of a new shop addition to its plant to be used for drop forge work. The structure, with adjoining warehouse, will be 180 x 400 feet, costing about $100,000.

SPRINGFIELD.—The Springfield Glazed Paper Company is planning for the erection of an addition to its plant.

Michigan

GRAND RAPIDS.—The Imperial Chemical Company, manufacturer of chemicals, is planning for the construction of a large addition to its plant on Ann Street, to provide for the constantly increasing demand for its products. The company recently filed notice of an increase in its capitalization from $100,000 to $200,000. Walter Ioor is president and treasurer of the company.

Missouri

ST. LOUIS.—The Bulls Manufacturing Company, 1122 South Twelfth Street, manufacturer of corrugated paper, is having plans prepared for the construction of a new one-story brick factory, about 153 x 380 feet, to cost $100,000, to be erected on Calvery Avenue, between Slevin and Brown Avenues. Will Levy, 1815 Wright Building, St. Louis, is the architect.

KANSAS CITY.—The Oxygen Gas Company, Traders Building, has had revised plans prepared for the erection of a new one-story and basement plant, about 44 x 102. The structure is estimated to cost $60,000. Keene & Simpson, Reliance Building, Kansas City, are the architects.

Nevada

ELKO.—The Standard Oil Shale Company is planning for the immediate erection of a large new 100-ton distilling plant on a tract of land acquired, about 4,260 acres, for the extraction of gasoline and greases from Nevada shale. The works are estimated to cost about $100,000. Headquarters of the company are at Salt Lake City, Utah. K. O. Day is president.

New Hampshire

MANCHESTER.—The Manchester Foundry Company is planning for the immediate erection of five large new additions to its works to provide for increased capacity. George A. Leighton is head of the company.

New York

NEW YORK.—The Aetna Explosives Corporation, Inc., 120 Broadway, will enlarge its plants for the manufacture of 18,000,000 pounds of trinitrotoluol and 12,000,000 pounds of picric acid for the Government.

NEW YORK.—The American Agricultural Chemical Company, 2 Rector Street, has acquired about 3,400 acres of phosphate land near Boyette, in Hillsborough County, Fla. The company is planning the construction of a large fertilizer factory and an acid phosphate manufacturing plant near Tampa, to cost about $1,000,000.

BROOKLYN.—The Brooklyn Union Gas Company, 176 Remsen Street, has taken out building permits for the construction of two two-story brick gas plants, each about 38 x 45 feet, on Smith Street, near Fifth Street. The structures will cost $20,000.

BROOKLYN.—Fire recently destroyed a portion of the plant of the Knowles-Bradley Manufacturing Company, with loss estimated at about $75,000. The company was working on a Government contract for the manufacture of saltpeter.

GENEVA.—The Seneca Paper Company is planning for the establishment of a large plant on a local site under consideration. This company is connected with the Compton Manufacturing Company of Rochester, and it is reported that the Compton Company is planning for the removal of its plant to this location.

DEPEW.—Arrangements have been completed for the Government to take over and operate the large plant of the American Car & Foundry Company. The factory will be devoted to the manufacture of shells exclusively.

NIAGARA FALLS, N. Y.—W. Ralston & Company, Ltd., Whirlpool Street, manu-

facturers of waterproof paper, have had plans prepared for the construction of a new one-story factory building, about 36 x 120 feet. The Allen Smith Company, 327 Fifth Street, is the architect.

LOCKPORT.—Fire, on December 2, destroyed a portion of the plant of the Lockport Paper Company, Mill Street, with loss estimated at about $20,000. The company is planning to install small dynamos temporarily to keep the mill running until the large dynamos can be installed. Wallace I. Keep is head of the company.

Ohio

AKRON.—The Amazon Rubber Company, East Market Street and Massilon Road, is making rapid progress in the construction of a new one-story factory on Britton Road. The new structure is to provide for increased capacity, and is about 60 x 70 feet.

CLEVELAND.—The Acorn Refining Company, 8205 Franklin Avenue, is planning for the construction of a new factory and storage building at its plant. The structure will be two-story, about 60 x 86, and will cost $30,000.

CLEVELAND.—The Manufacturers Oil & Grease Company has acquired property at Junction Road, S. W., and the Big Four tracks, about 400 x 500 feet, and is planning for the erection of a large new factory.

URBANA.—The Central Glass Company is making rapid progress in the alteration and improvement of the plant of the former Eagle Glass Company, and it is expected to inaugurate operations at an early date.

YOUNGSTOWN.—The Ft. Smith Spelter Company has acquired a large rolling mill plant at Greencastle, Inc., and is planning for the organization of a large new $1,000,000 corporation, for the purpose of constructing a sheet zinc manufacturing plant of ten mills. It is planned to supply the new works with raw material in the form of slab zinc from the Ft. Smith spelter plant at Ft. Smith, Ark. D. W. Kerr, Youngstown, is president of the company.

ZANESVILLE.—The Dresden Paper Mills are making rapid progress in the construction of a large new addition to its plant. The structure will be about 45 x 130 feet, and is to provide for increased capacity. Handshy & Son, Zanesville, are the contractors.

Oklahoma

ENID.—The Oil State Refining Company has awarded contracts for the erection of a large 2,500-barrel refinery, and the company is planning to inaugurate operations in the first unit of the plant in about 100 days. The plant will then have a capacity of about 1,000 barrels daily.

LAWTON.—Fire recently destroyed the plant of the Temple Cotton Oil Company, with loss estimated at about $55,000. E. L. Richardson is president and manager.

HENRYETTA.—Work has been started on the construction of the new refinery for the Neupro Refining Company, which will be one of the largest in this section of the state. The plant is being erected at a cost of about $80,000. It is expected to inaugurate operations about March 1.

Pennsylvania

HEIDELBERG.—Fire on December 5 completely destroyed the chemical manufacturing plant of the Aetna Chemical Company, near Pittsburgh.

PHILADELPHIA.—The M. Kardon Paper Company has had plans prepared for the construction of a new one-story brick and steel addition to its plant on 224 Pine Street, about 40 x 115 feet. Herman H. Kline, Sixth and Mifflin Streets, Philadelphia, is the architect.

PHILADELPHIA. — Fire recently destroyed a portion of the glass manufacturing plant of Gill & Company, York and Thompson Streets, with loss estimated at $10,000. It is said the works will be immediately rebuilt.

PHILADELPHIA.—The Penn Chemical Company is completing extensive improvements in its local plant. The company is now building a one-story addition to cost about $25,000.

PHILADELPHIA. — The Tacony Ordnance Company, Tacony, near Philadelphia, has had plans prepared for the construction of a new two-story brick laboratory building, about 25 x 37 feet.

SHARON.—Extensive improvements are now in progress at the Carnegie Steel Company plant, and new ore bins, ore bridges and other extensions will also be erected. Plans have been prepared for the enlargement of blast furnaces Nos. 2 and 3, to increase the present capacity to from 500 to 600 tons daily.

Rhode Island

PROVIDENCE. — The Stillman White Foundry Company has had plans prepared for the erection of a new two-story addition to its plant, about 26 x 40 feet.

South Dakota

LEAD.—The Homestake Gold Mining Co., of South Dakota, has placed an order with the Hardinge Conical Mill Co. for an 8-ft. conical ball mill. This mill will work in conjunction with the stamps of that company, which now has over 1000 stamps in daily operation.

Tennessee

KINGSPORT.—The Clinchfield Portland Cement Corporation is making rapid progress in the construction of its new potash plant, which will be devoted to the manufacture of potash from the waste dust and gases generated in the production of Portland cement. The new plant is estimated to cost $200,000.

Texas

HOUSTON.—Fire recently destroyed a portion of the plant of the Tofte Boiler & Sheet Iron Works, with loss estimated at $40,000, of which $20,000 was in machinery. It is said that the plant will be rebuilt.

TEXAS CITY.—The Pierce-Fordyce Oil Association, manufacturer of oils, greases, paraffine wax, etc., is building several new storage tanks at its plant. The facilities of the works are being constantly added to, and its capacity is now practically double what it was two years ago. The company operates in three eight-hour shifts.

Utah

ALUNITE.—The Mineral Products Company is rushing to completion the construction of the first unit of the new fireproof plant to replace the works recently destroyed by fire with loss of about $250 000. The new plant is estimated to cost $1,000,000.

SALT LAKE CITY.—The Koering Cyaniding Process Company, Detroit, Mich., is planning for the removal of its offices and works, and will establish its laboratories locally. Dr. Maximilian Markus is secretary and treasurer of the company.

Vermont

WINDSOR. — The Cooley-Wright Company, operating a large foundry at Waterbury, is planning for the establishment of a new local foundry. A factory building has been acquired, and improvements and alterations will be made to meet the requirements of the company.

Virginia

CHARLOTTESVILLE. — The American Sulphides Corporation, recently incorporated with a capital of $400,000, is planning for the development of 600 acres of land, with a daily capacity of 150 tons. Alvin T. Embrey, Fredericksburg, is president of the company.

Canada

SAULT STE. MARIE, ONT.—The Wilputte Coke Oven Corporation, of New York City, has been awarded a contract for the installation of twenty-five Wilputte regenerative by-product coke ovens, with certain by-product equipment, as an extension to the present coke oven plant of the Algoma Steel Corporation, Ltd., at Sault Ste. Marie, Ontario, Canada. Work will be started immediately, and the construction is expected to be completed by July 1st, 1918.

Manufacturers' Notes

THE ASBESTOS PROTECTED METAL COMPANY of Pittsburgh, Pa., announces that on and after December 1st, 1917, it will be represented in the state of Georgia by J. F. Schofield's Sons Company located at Macon.

W. L. FLEISHER & CO., contracting industrial engineers of New York City, removed their offices on December 1 to 31 Union Square West.

THE ELECTRIC FURNACE CONSTRUCTION COMPANY of Philadelphia announce the sale of a "Greaves-Etchells" electric furnace to the Ford Motor works of Detroit, Mich. This furnace is in connection with special government aircraft work. They also announce the sale of two 3-ton furnaces to the Halcomb Steel Company of Syracuse, N. Y., which will also be used for special aeroplane and motor steels.

THE PFAUDLER CO., Rochester, N. Y., has established a branch sales office at 440 Pierce Building, St. Louis, Mo., in charge of Mr. George E. Gray, who has, for some time, been connected with the Chicago office. The agency for the company's products has been granted to C. M. Jackson Co., 512 Gould Building, Atlanta, Ga.

E. S. LINCOLN, INC., has removed from Waterville to 534 Congress Street, Portland, Me., where the laboratory will be maintained similar to that at Waterville.

Manufacturers' Catalogs

NORTON COMPANY, Worcester, Mass., has issued a complete little booklet on tool room grinding.

NUTTALL, Pittsburgh, has issued a new catalog on Nuttall Industrial products, gears, pinions, etc.

BACHARACH INDUSTRIAL INSTRUMENT CO., Pittsburgh, Pa., has issued catalog D describing the "hydro" pressure recorder.

THE BORDEN COMPANY, Warren, Ohio, has issued its 1918 catalog of Beaver die stocks and square-end tube cutter.

WORTHINGTON PUMP AND MACHINERY CORPORATION of New York City has issued catalog D-1301 on Deane automatic pumps and receivers.

CENTRAL SCIENTIFIC COMPANY, Chicago, has issued Bulletin No. 50 describing a new de Khotinsky single walled drying oven.

THE DENVER ENGINEERING WORKS COMPANY, Denver, Colo., has issued Bulletin No. 1078 describing the Richards improved pulsator jig.

THE J. P. DEVINE COMPANY, Buffalo, N. Y., has just issued Bulletin No. 104, covering its patented vacuum drying and impregnating apparatus, which gives detailed information of the equipment developed for use for impregnation of armature, field, magnet and transformer coils, power and telephone cables and insulator pins. The bulletin also describes special cable dryers and combined cable dryers and vulcanizers.

New Publications

WOMEN'S WORK IN WAR-TIME. Published by the Merchants National Bank of Boston, Mass., to assist manufacturers in this country in meeting the shortage of labor. This information has been obtained direct from the British Government and other authoritative sources. The operation of the leading industries in England wherein women have replaced men are outlined and have been changed to meet individual conditions in this country.

SILVER, COPPER, LEAD AND ZINC IN THE CENTRAL STATES IN 1916. Geological Survey Report by J. P. Dunlop and B. S. Butler.

GOLD, SILVER, COPPER AND LEAD IN ALASKA IN 1916. Geological Survey Report by A. H. Brooks.

THE TRAINING AND WORK OF THE CHEMICAL ENGINEER. Reprinted from Transactions of Faraday Society, 82 Victoria Street, London, Eng.

BLAST FURNACE BREAKOUTS, EXPLOSIONS AND SLIPS. Bureau of Mines Bulletin 130, by F. H. Willcox.

IRON ORE OCCURRENCES IN CANADA. Department of Mines Publication No. 217, by E. Lindeman and L. L. Belton. Two volumes.

BARYTES AND BARIUM PRODUCTS IN 1916. By James M. Hill, pages 243 to 254 of Mineral Resources of the United States, 1916—Part II, published Sept. 20.

SILICA IN 1916. By Frank J. Katz, pages 283 to 287 of Mineral Resources of the United States, 1916—Part II, published Sept. 24.

SECONDARY METALS IN 1916. By J. P. Dunlop, pages 39 to 52 of Mineral Resources of the United States, 1916—Part II, published Oct. 6.

LABORATORY DETERMINATION OF THE EXPLOSIBILITY OF COAL DUST AND AIR MIXTURES. By J. K. Clement and J. N. Lawrence. Technical Paper 141 of the Department of the Interior, Bureau of Mines.

EFFECTS OF HEAT ON CELLULOID AND SIMILAR MATERIALS. By H. N. Stokes and H. C. P. Weber. Technologic Paper of the Bureau of Standards No. 98, issued Oct. 15, 1917. Price 5 cents.

THE PRODUCTION OF IRON AND STEEL IN CANADA DURING THE CALENDAR YEAR 1916. By John McLeish. Bulletin No. 458, published by the Canadian Department of Mines.

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